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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 7, 1895.

THE GAY SCIENCE OF ARITHMETIC.

L'Arithmétique Amusante. Par Édouard Lucas. Pp. i.–viii. 1–266. (Paris: Gauthier-Villars et Fils, 1895.)

Traité d'Aritmétique. Par C.-A. Laisant et E. Lemoine. Pp. i.–viii. 1–174. (Paris: Gauthier-Villars et Fils, 1895.)

BY the premature death of Édouard Lucas the world lost at once a wit, a scholar, and an original mathematician. This somewhat rare combination of qualities is evident in all his work, and especially in the inimitable "Récréations Mathématiques," which, to those who are able to appreciate it, will always be one of the most entertaining of books. The interest of the problems themselves, the lucidity with which they are discussed, and the brilliant appropriateness of the author's dedications and mottoes, combine to invest the work with a charm peculiarly its own.

It will be remembered that, shortly after Lucas's death, a commission was appointed by the Mathematical Society of France, consisting of the President of the Society for the time being and MM. Delannoy, Laisant and Lemoine, for the purpose of examining and classifying the unpublished manuscripts of the deceased mathematician. Two additional volumes of the "Récréations" were found practically ready for press, and these were published by the commission in 1893 and 1894 respectively. Although they unavoidably suffer to some extent from the lack of the author's final revision (for instance, we miss the usual witty dedication in some cases), these additional volumes are well worthy to rank with their predecessors.

The first of the books now under review is edited by the same commission, and is uniform in size and style with the "Récréations." It is, indeed, described on the title-page (presumably by the editors) as an introduction to the former work; but this, though true in a sense, is rather misleading. It appears from the editors' preface that, so long ago as 1885, Lucas had in preparation a book to be called "l'Arithmétique amusante," and three manuscript note-books bearing this title were found among his papers. The book now published, or rather the first part of it (pp. 1–186), contains the text of these note-books; the remainder consists of a series of four notes, which form a kind of supplement to the "Récréations," and complete the publication of all that Lucas has left relating to this subject.

By far the greater portion of the first part of the book has already appeared, nearly verbatim, in the "Récreations"; the rest consists partly of arithmetical curiosities, such as

$$8 \times 123456789 + 9 = 987654321,$$

and partly of well-known tricks and puzzles, some of which are not even arithmetical; as, for instance, how to convert a 3 into a 5 by a single stroke of the pen. This may be amusing, but is not arithmetic.

Mathematicians in search of novelty will turn with more interest to the notes which fill up the remainder of the volume. Note i. is the text of an address delivered by Lucas on August 4, 1885, at the prize-day of the Lycée Saint-Louis. Note ii. contains two interesting modifications of the problem of the jealous husbands and their wives. Note iii. gives a brief account of the scientific games invented by Lucas. Note iv., which is the most important, comprises different fragments relating to the "Récréations." These are six in number, and deal with the problem of the eight queens, games with ribbons, magic squares and cubes, and the knight's tour. The last problem, in particular, is discussed at some length.

It will be seen from what has been said that the appearance of this book adds little to Lucas's reputation, although, of course, it does nothing to diminish it. In preparing it for publication, the editors have performed a pious duty, for which they deserve our grateful acknowledgments; and the work is likely to appeal successfully to two classes of readers. The happy possessors of the "Récréations" will not rest until they have procured this supplementary volume for the sake of the notes, or for the æsthetic purpose of completing their set; while those who are not so fortunate will be able to make the acquaintance of the author in a comparatively easy and inexpensive way. It is only fair to warn them that, in all probability, they will feel constrained to buy the larger work afterwards.

The treatise of MM. Laisant and Lemoine is intended to serve a double purpose: to provide a strictly scientific introduction to the science of arithmetic, and to exemplify a system of orthography which has been adopted by the "Société filologique française." This is not the place to discuss the system of spelling which is advocated: suffice it to say that it is one of those compromising systems which, while rebelling against tradition, stop short, by a long way, of a strictly phonetic orthography. The consequence is a mass of inconsistency which has not even the excuse of a historical development: thus, for instance, "philosophie" becomes "filosofie," while "science" retains its traditional form. Again, "commun" is changed into "comun," while "irréductible" is left alone.

From a mathematical point of view, the book, as might be expected from the reputation of its authors, is very interesting and valuable. A treatise on elementary arithmetic may be criticised in two different ways, according as it is estimated in relation to pure science or to pedagogy. Most text-books on arithmetic are utterly unscientific, and a treatise like this, which aims at a rigorous method and, on the whole, achieves it, is a welcome acquisition.

The book deals with the four fundamental operations as applied to whole numbers and fractions; the metric system; elementary theory of numbers (prime factors, G.C.M. and L.C.M., recurring decimals, &c.); incommensurables, squares and square roots; ratio and proportion. Most of it is quite admirable; and the criticisms which follow are offered in no captious spirit, but as a kind of acknowledgment of the really scientific character of the book.

The authors begin by defining addition as an operation which is independent of the order of the things added; or rather they refrain from giving a definition of addition, and state that any definition must be subject to the condition above stated. Now in arithmetic it is not things, but numbers, that are added, and it is quite possible to give a satisfactory definition of an arithmetical sum. Thus take two groups of objects (in the most abstract sense), count the first group, then the second, and thirdly count the first group as before, but *go on counting* as you pass on to the second group instead of beginning again. Three numbers are thus obtained, and the third is defined to be the result of adding the second to the first. The commutative law follows easily enough.

The authors' definition of a sum is equally applicable to the addition of vectors, and this fact vitiates their statement that "a quantity A is said to be greater than another quantity B when A results from the addition of a quantity C to B."

The objection that concrete "quantities" are introduced, whereas pure arithmetic is concerned with numbers, and numbers only, applies to other parts of the book, notably to the chapter on fractions. It is quite true that concrete illustrations, such as those afforded by a two-foot rule, are very useful, and indeed indispensable for the purposes of primary instruction in the subject, but the *theory* of fractions is independent of these applications. This may be seen, for instance, in Biermann's "Theorie der analytischen Functionen" (after Weierstrass); and it is not difficult to see in Euclid's arithmetical books some foreshadowing of this way of looking at the matter.

Then, again, the treatment of irrational numbers, although greatly superior to that usually found in text-books, does not seem wholly satisfactory. The authors evidently intend to adopt the method of Dedekind, or rather, perhaps, that of Heine, but the way in which this is presented is not very clear. According to Dedekind, the existence of a single definite irrational or transcendental number is established when we are able to define a "Schnitt" in the (discrete) multiplicity of rational numbers; that is to say, when we are able to find a criterion which separates *all* rational numbers into two groups, A and B, such that every number, say a, which belongs to A, is greater than every number b which belongs to B. Thus, for instance, if we assign a rational number to A when its square exceeds 2, and to B when its square is less than 2, we establish a "Schnitt" which defines the irrational number $\sqrt{2}$. Heine's method is not very different from Dedekind's; thus his way of defining $\sqrt{2}$ consists in selecting from the groups A and B, as above defined, two sets of rational numbers:—

$$a_1,\ a_2,\ a_3\ .\ .\ .\ a_n\ .\ .\ .$$
$$b_1,\ b_2,\ b_3\ .\ .\ .\ b_n\ .\ .\ .$$

such that

$$a_1 > a_2 > a_3 > \ .\ .\ .\ > a_n > \ .\ .\ .\ (a_n^2 > 2)$$
$$b_1 < b_2 < b_3 < \ .\ .\ .\ < b_n < \ .\ .\ .\ b_n^2 < 2)$$

and then showing that if n, m are taken large enough, $a_n - b_m$ can be made as small as we please. MM. Laisant and Lemoine, after introducing the problem of measuring an incommensurable quantity, proceed: 'Jusqu' à présent on n'a rien trouvé de mieus pour remplir ce but que d'indiquer tous les nombres entiers ou fractionaires mesurant les quantités plus grandes et les quantités plus petites que A." Now, even if we waive the objection already brought forward, that the measurement of *quantities* is independent of pure arithmetic, and that the assumption that every quantity admits of arithmetical measurement in terms of an arbitrary unit requires justification (and this can only be given *after* the theory of irrational numbers has been established, if indeed then), the above statement is not satisfactory; because if A is really a concrete quantity, the "nombres entiers ou fractionaires," &c., can only mean "quantities commensurable with an assumed unit," and it remains to be proved that the choice of a unit has no influence on the result; while if A is a number, no criterion is given by which we can decide whether a given rational number is greater or less than A. On this point we cannot do better than refer to the preface to Dedekind's invaluable tract, "Was sind und was sollen die Zahlen?" in which the author expressly rejects all theories of irrational numbers based on the assumption of measurable quantities. That he is right in so doing must be admitted by all who reflect on the subject with sufficient attention.

These observations, as already remarked, are not intended to detract from the undoubted merit of the book. Arithmetic is a thorny subject, the very elements of which abound in points of great difficulty and delicacy; and any serious work on the science is certain to contain passages giving occasion for criticism or controversy. MM. Laisant and Lemoine deserve our gratitude for having

written an original and stimulating book, which should be studied, not only by professed mathematicians, but by intelligent school teachers. Such a work ought to do much towards replacing the soul-destroying routine of ordinary school arithmetic by something of a really educative character.

In conclusion, we would ask the reader to turn to the chapter on the metric system, which contains in the compass of about a dozen pages all the "commercial arithmetic" which a French schoolboy has to learn. It seems impossible that any one, after reading this chapter, can refrain from asking himself how it is that the English nation persists in refusing to adopt a system which is as easy to learn as it is convenient to use, and which, as the experience of France has sufficiently shown, could be prescribed by the State without the risk of any, save the most transient, disturbance of trade or exchange. But we are a practical people, and the metric system was invented by "theoreticians"; therefore, we suppose, nails and perches and pennyweights will be with us to the end of time.

G. B. M.

THE STRUCTURE AND LIFE OF BIRDS.

The Structure and Life of Birds. By F. W. Headley, M.A., F.Z.S., Assistant Master at Haileybury College. 8vo. Pp. xx. + 412, with seventy-eight illustrations. (London: Macmillan and Co., 1895.)

THE author in his preface intimates that "the aim of this book is an ambitious one," namely, "to give good evidence of the development of birds from reptilian ancestors. . . . and [among other subjects] to make clear the main principles of their noble accomplishment, flight." To the former of these aims Mr. Headley devotes his first five chapters, comparing the differences and resemblances observable in the skeleton and the internal structure of birds and reptiles, and the "ancestral peculiarities" that, having "survived all change of habit," mark their relationship. He then discusses the processes of life that go on within the bird, and make it so different from its lethargic reptilian ancestors, giving a description of the anatomical structure and physiological action of its chief organs. The following paragraph, from the description of the heart and circulation, will exemplify Mr. Headley's style and method of exposition:—

"The heart is a force-pump, which drives the blood to all parts of the body, and when it returns impure and loaded with used-up material, sends it to the lungs to be purified, after which it is despatched all over the body again. On the voyage much of it passes through the kidneys, which help the lungs to purge it of the waste of the tissues. The essentials of an efficient heart are that it should be strong, and that it should keep the pure blood separate from the impure. These two essentials are found combined in the hearts of mammals and birds. They are strong muscles; that part at least of them which forces the blood through the arteries is remarkable for its strong thick walls. And, thanks to the perfection of the machinery, the blood which has been purified in the lungs is never mixed with the impure blood which is coming from the body. The heart is divided into right and left chambers by a division through which there are no doorways. The right and left chambers are each divided into two, but there are openings from the upper into the lower, which may be closed by valves. The two lower chambers are called ventricles, and the two upper ones auricles."

A long chapter is next given to flight, one of the main subjects of the book; the machinery by which flight is accomplished, and the principles underlying the action of its complicated mechanism, with the extraneous aids the bird avails itself of to effect that purpose. Towards a solution of this difficult subject, on which, as the author remarks, "however much is learnt, a great deal more remains to be learned," he has contributed some original observations and experiments, for which we refer the reader to the book itself. A condensed but clear account of the bird's embryology and its subsequent life-history occupies several succeeding chapters. After this the book deals principally with colour and song, instinct and reason, migration and the principles of classification.

There is one statement made by the author, in speaking of the pneumaticity of the bird's bones, to which we feel inclined to take exception. Mr. Headley says on p. 107: "The hornbills, which according to good observers are very poor flyers, are as pneumatic [as to their bones] as any birds, or, perhaps, more so." The present writer's experience of hornbills in their native state extends to many species of several genera, among them the largest and heaviest of them all, the great solid-headed *Buceros galeatus*. Many of these birds, which may be seen—and the rush of their expansive wings can be heard long before that—constantly travelling at a great speed high over the tall virgin forests, and be watched by eye and ear for miles after they have passed over the observer, can scarcely, in his estimation, be accurately designated "poor flyers." They may not take such extended flights as birds on migration do, but they make journeys of considerable length; while in the tops of the highest trees, in quest of their food, they are quite as active and nimbly expert as those excellent flyers, the pigeons, which share with them their raids on the giant Urostigmas.

The volume before us presents little to take exception to, and it will be generally conceded that Mr. Headley has succeeded well in the aims he set before himself. He has produced a very instructive and thoroughly scientific book expressed in popular language, and one that will undoubtedly "prove useful," as he hopes it may, "to lovers of birds"; and, from the clear and concise manner in which the story of the bird's pedigree and life-history is narrated, it will be specially welcome to those of them who have not had the advantage of a scientific training in the subject; while it can scarcely fail to attract many of its readers, on the outlook for a spare-time occupation, to the study of ornithology, on which it will start them with a trustworthy groundwork.

OUR BOOK SHELF.

Fern Growing. Fifty years' Experience in Crossing and Cultivation, with a List of the most Important Varieties, and a History of the Discovery of Multiple Parentage, &c. By E. J. Lowe, F.R.S., F.L.S., &c. (London: John C. Nimmo, 1895.)

MR. LOWE'S name is so well known in connection with the production of hybrid ferns, that his book will be opened with interest by all those to whom the cultivation of these plants in any way appeals. But we must confess that the book falls somewhat short of our expectations

It is true that a very considerable space is devoted to the history of the production of hybrid forms, and that an account is given of the methods of securing successful germination of spores; but those who expect to find a treatise on the cultivation of ferns *per se*, will not find their hopes realised.

The author again takes up cudgels in defence of his views as to the existence of *multiple parentage*, a term used to express his conviction that a single oosphere can be fertilised by several antherozoids, or at the least, that a number of fertilised oospheres on one prothallium can influence the one which actually develops into a seedling plant. It is true that some of the experiments adduced by the author in support of his contention offer startling results. Thus, if a pan be sown with the spores of, say, four varieties, in a large percentage of the seedlings each will exhibit resemblances to all the four forms, instead of to only two, at most, of them. And this latitude of variation exercised in the case of a single seedling is stated to depend on the number of varieties which are sown together, and not to accidental sports.

But the inferences thus drawn by the author are so entirely at variance with the results of experimental investigations on the higher organisms, that they will meet with a cautious reception, at any rate, until the factors which make up his results have been analysed and are better understood.

Whatever the ultimate verdict which will be passed on the theoretical conclusions may be, the details of the experimental basis on which they rest, provide interesting matter enough, and suggest fresh lines of investigation which may well prove fruitful in results.

Vorlesungen aus der analytischen Geometrie der Kegelschnitte. By Sigmund Gundelfinger. Edited by Friedrich Dingeldey. 8vo. viii. + 434 pp. (Leipzig: Teubner, 1895.)

THE first part of this book (pp. 1–240) is an edition of lectures on Conics delivered by Gundelfinger within the last twenty years in the University of Tübingen and the Technical School at Darmstadt. It contains a systematic exposition of the analytical theory of Conics based on the use of general homogeneous coordinates which are so arranged that corresponding results in particular homogeneous coordinates and in ordinary Cartesian coordinates can be written down from the results obtained. It also contains an exposition of the theory of sets of Conics, including four-point and four-tangent Conics, and nets and webs of Conics. The theory is not written out with the idea of enumerating all the independent concomitant forms, but with the idea of expressing the geometrical significance of the most important ones. The appendix (pp. 240-426) contains solutions of problems on the subjects treated in the first part. Many of the problems are taken from the works of Steiner, some are original, and not a few are difficult. A very complete index is given at the end of the book.

Light. By H. P. Highton, M.A. Pp. 243. (London: Rivington, Percival, and Co., 1895.)

BOOKS upon light are many and of various qualities, but we think there is room for this little one. The subject is treated in a very elementary manner, and is made easy of comprehension by numerous diagrams. A further good point possessed by the book is that the lessons comprised in it are fully illustrated by experiments, all of which are capable of being carried out by teachers whose apparatus cupboards only contain a small stock of materials for the demonstration of optical facts and principles. The boy who goes through a course such as that described by Mr. Highton, and who sees all the experiments performed, will obtain a fair notion of the laws of light; and if he does the experiments himself, he will benefit considerably by the manual and mental training which his work will give him.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Curious Aerial or Subterranean Sounds.

IF the mysterious sounds referred to by Prof. G. H. Darwin should turn out to be of subterranean origin, as is not unlikely the case, it may be that they are the reports arising from the process of "faulting" going on on a small scale at a great depth, and not of sufficient intensity to produce a perceptible vibration at the earth's surface. In this connection I may recall an observation which bears upon the subject. When collecting materials for the report on the East Anglian earthquake of 1884, I was given a most circumstantial description of a loud report which was heard by the chief officer of the coastguard station at West Mersea during his watch between 1.10 and 1.20 a.m. on February 18 of that year. The sky was cloudless at the time, there was no flash such as might have been expected if the sound had been due to thunder or the explosion of a meteorite, and there was no artillery sufficiently within hearing to account for the sound. This report heard by the coastguard officer was afterwards found to have been *felt* as a slight shock at a house which was very much damaged by the earthquake which occurred a few weeks later (April 22), and we came to the conclusion that the officer and the inhabitant of the house in question had independently recorded a premonitory shock ("Report," p. 40, by the writer, and W. White, "Essex Field Club Special Memoirs," vol. i.). When Prof. Darwin's request for information shall have led to further knowledge as to the localities where the phenomenon has been observed, it would be of great interest to have in such places instruments for recording earth tremors. R. MELDOLA.

November 3.

Is it not possible that the "Berisàl Guns" and "mist pouffers," referred to by Prof. Darwin (p. 650), are merely earthquake sounds, the attendant shock being too slight to be otherwise perceptible? Nearly all earthquakes are accompanied by a rumbling sound, due, I believe, to the small and rapid vibrations proceeding chiefly from the margins of the area over which the fault-slip producing the earthquake takes place (*Geol. Mag.*, vol. ix., 1892, pp. 208–218). In some districts (Comrie in Perthshire, East Haddan, in Connecticut, Pignerol in Piedmont, Meleda in the Adriatic, &c.), sounds without shocks are common during intervals which may last for several years, but slight shocks with sound occasionally intervene, as if the sounds and shocks were manifestations, differing only in degree and the method in which we perceive them, of one and the same phenomenon. In great earthquakes, the sound-area is confined to the neighbourhood of the epicentre; in moderate and slight shocks the sound-area and disturbed area approximately coincide, or the sound-area may even overlap the disturbed area. In the limiting case, the disturbed area vanishes, and the vibrations are perceptible only as sound. C. DAVISON.

Birmingham, November 1.

Thermal Conductivity of Rocks.

IN view of recent discussions in NATURE anent the variation of the thermal conductivity of different kinds of rock with the temperature, the following results of an investigation, which has been in progress for the last year in the Jefferson Physical Laboratory, may be of interest.

We have made observations upon piles of comparatively large flat slabs of marble and slate by a form of "wall" method, and we hope that we have determined, with some accuracy, the internal temperature gradient.

We can detect no change in the conductivity of the block of white Carrara marble which we have used between 0° C. and 330° C.

In the case of our slate, the conductivity in a plane perpendicular to the cleavage increases about 25 or 30 per cent. between 70° C. and 300° C., the rate of increase being less rapid at the higher temperatures. B. O. PIERCE.

Cambridge, Mass., October 20. R. W. WILLSON.

MacCullagh's Theory of the Æther.

MR. BASSET'S criticisms in his letters in NATURE of October 17 (p. 595) and October 24 (p. 618) call for some reply. I willingly avail myself of the opportunity to attempt to make my meaning clearer.

(1) As regards the first letter, there seems to be some misconception. I have nowhere in the papers referred to given a proof, such as he supposes, of the theorem which he calls in question, viz. that a gyrostatic æther may be constructed which will function according to MacCullagh's optical scheme. That proposition is, I take it, Lord Kelvin's; and I simply gave references to his treatment, which occurs, at any rate implicity, near the end of the third volume of his "Collected Papers" (pp. 442, 466).

The principal aim of the second of the papers referred to (*Phil. Trans.* A, 1894) was, assuming the existence of a continuous medium with kinetic and elastic energies given by MacCullagh's expressions, to examine how far such a medium would fulfil the functions that are required of the æther, as (i.) the transmitter of radiation, (ii.) the medium in which electric actions consist and are transmitted, (iii.) the underlying medium in which ordinary matter may itself consist, in the form of permanent configurations of strain or motion possessing mobile characteristics. In MacCullagh's own time it was recognised, by none more than by himself, that a medium like his was in no way analogous to ordinary elastic matter. Moreover it was held by many that it was an impossible constitution for any medium at all. This latter conclusion I combatted by quoting the fact that Lord Kelvin has actually shown how to make a model, representing MacCullagh's medium, by means of a cellular structure composed of portions of ordinary matter in spinning motion. This is the only way that I intended to introduce the gyrostatic æther into the argument. For I hold it to be more rational to take matter to be a structure of molecular type in the primordial medium (which is not itself matter, but is a *continuum* with simpler fundamental properties than elastic solid matter) than it would be to take the æther to be a molecular or cellular structure built up out of ordinary matter.

The functions required of the æther show that it must be a medium which can have kinetic energy involving inertia, and also elastic energy of some kind when strained. According to MacCullagh's scheme, its elasticity would consist simply in resistance to absolute rotation; so that an element of volume of the medium is taken to have relations to directions in space, of the same general type as the axis of a spinning gyrostat actually possesses. The analysis of the interaction of this inertia and this elasticity forms a dynamical theory of the medium, but the dynamics is not the dynamics of ordinary matter.

Mr. Basset easily arrives at inconsistencies by applying MacCullagh's energy formula directly to the structural gyrostatic medium of Lord Kelvin. The reason is that the problem is one involving ignored coordinates (in the phraseology of Thomson and Tait's "Natural Philosophy") corresponding to the latent spinning motions of the imbedded gyrostats. Before the principle of least action can be applied after the manner of an ordinary continuous elastic medium, the actual energy function of the gyrostatic medium must be modified in the well-known manner, and it will thus assume a form equivalent to MacCullagh's. It would, no doubt, be interesting and instructive, as regards dynamical principles, to establish this in detail; but this is hardly the place to enter into a technical problem.

(2) As regards Mr. Basset's second letter, on the reflection of light from the surface of a magnet, the parallel which he draws between one type of theory which I provisionally uphold, and another which I reject, is, I think, not a real one. The latter theory retains the dynamical equations and surface conditions which belong to the luminiferous medium under ordinary circumstances, merely adding on to the electric force a new part of magneto-optic origin. This would hardly be open to objection if it worked; but it is admitted that it does not work, and in default of a specific reason being assigned for the discrepancy the theory fails. It is as if a machine, whose mode of working is thoroughly known under certain simple conditions, were observed to be working steadily under more complicated circumstances, while a mathematical analysis showed that it ought to get jammed under these new conditions. The inference would, I think, be that the machine has been reset, or some change made in its constitution, which obviated the jamming. Now the ordinary equations of the electric theory of light are, presumably, deducible from the energy function of the medium by the principle of least action. When the substance that transmits the light is in an extraneous magnetic field, there is a subsidiary term in the energy function which arises from this field; therefore the application of the principle of least action will now give different equations of the medium, and different boundary conditions, from those which ordinarily hold good. The statement that the boundary conditions which held for non-magnetic circumstances are not now maintained, is not to the point; the question is rather, whether the boundary conditions which are appropriate to the actual formulation of the problem can all be maintained, and if they can the theory is consistent.

J. LARMOR.

St. John's College, Cambridge, October 25.

Lightning.—Chain Formation.

ON September 9, 1895, I was cycling near Pitlochry, N.B. The day had been extremely hot—80° F. in the shade—and as dusk came on it grew somewhat foggy, and flashes of distant lightning became frequent. At ten o'clock there suddenly came on a terrific thunder-storm. Crash succeeded crash, and the lightning, of all colours, blazed almost continuously. Objects fifteen miles off could be seen as plainly, if not more so, than in bright daylight. The rain soon turned the road into a torrent, and my electric lamp failed to act properly. But the chief peculiarity was the occurrence of eight strange flashes of a chain formation, with large elliptical links, and of a golden-yellow colour. These flashes were not rapid in their passage, as ordinary lightning is wont to be; but one of them took slightly over a minute to pour from the clouds to the edge of the valley opposite me. Two of these chains of living, burning gold passed between adjacent clouds, while the remaining six came to earth, one in the field just beside me. I then went off to seek for shelter; but the storm continued till 1 a.m.

WILLIAM CRAWFORD.

Personal Injury from a Fire-ball.

IN compliance with a wish expressed by several scientific friends, I place on record an instance of damage done by a fire-ball or globular lightning. About five weeks ago, when I was in Londonderry, the circumstances were related to me by Mr. James Harvey, of Northland Road in that city. Mr. Harvey was staying during the month of August at Culdaff, on the north coast of Donegal; and on the 24th of that month, at about 4 p.m., a little boy named Robert Alcorn, whose parents occupied a house near Mr. Harvey's, was desired by his father to go into the yard and drive away some fowls from the door. On going out of the house, the boy saw a large bright object in the sky about the size of the table in his bedroom (I give his own account, leaving out necessary considerations of distances, &c.), or apparently about six square feet in area. The object came towards his house from the west, or north-west; and when it came close, it partly burst with a report like that of a gun. He put his hands over his face to shield himself from "the spark," and after the explosion the bulk of the ball appeared to continue its course towards the east, low down. When it burst, however, it struck him, shattering the thumb and the first and second fingers of the left hand, cutting, scratching, and blackening the right hand and left cheek, and shattering into fragments several bone buttons on his coat. Very soon afterwards, Dr. R. Young, of Culdaff, and Dr. Newell, of Moville, attended the boy, and amputated the fingers and a portion of the thumb.

No one near the place *saw* the ball (except the boy, of course), but the parents and several others heard the report, and the boy's father rushed out immediately and caught his son as he was falling. Mr. Harvey soon afterwards examined the place, and could find no further trace of the fire-ball, except that a piece of bark had been knocked off a small tree within a few feet of the place where the boy was struck. The local police made exhaustive inquiry as regards the possibility of any one's having fired a gun at the boy, or of his having had any explosive in his possession; but nothing of the kind transpired.

It is well to add that at Redcastle (about eight miles away), one of the residents saw, on the same day, a bright object in the sky, which object he took to be a fire-ball. The day was stormy, with heavy showers, but no thunder.

M. Jamin relates ("Cours de Physique," tome premier, p. 470) several instances of globular lightning, and from these I select

the following as bearing, perhaps, the greatest resemblance to the above case as regards atmospheric conditions:—

"À la suite d'un violent orage observé près de Wakefield, le 1er mars 1774, lorsqu'il ne restait plus dans tout le ciel que deux nuages peu élevés au-dessus de l'horizon, M. Nicholson voyait à chaque instant des météores semblables à des étoiles filantes descendre du nuage supérieur au nuage inférieur."

October 28. GEORGE M. MINCHIN.

The Dispersal of Acorns by Rooks.

IN peat-mosses, on open chalk downs, and in ploughed fields, often a mile or more from the nearest mature tree, one constantly finds acorn-husks and also seedling oaks, which last a few months or, perhaps, a couple of years, and then die, the conditions being unfavourable. It has always seemed to me, while studying the origin of the existing fauna and flora of Britain, that this dispersal of acorns ought to give an important clue to the means by which this country was again clothed when the climate became more genial after the Glacial Epoch. The oak has the largest seed of any British plant, and if it can be carried distances of a mile or more, it is evident that the whole of our present flora may have spread more rapidly than is usually imagined, and may have crossed straits and wide rivers.

I have for several years noted the position of these seedling oaks, finding them in places where no mammal would take the acorns. For instance, they are common in any of the New Forest peat-bogs that are within a mile of an oak-tree. They are common also in some places on the top of the escarpment of the South Downs, half a mile from oaks, and 300 or 400 feet above them. They are always associated with empty acorn-husks, stabbed and torn in a peculiar way.

In October and November rooks feed in the oak-trees, and I have long felt convinced that they were mainly responsible for the dispersal of acorns, though it is not easy to catch them actually doing it. On October 29 of this year I was successful. In the middle of an extensive field, bordered by an oak-copse and scattered trees, a flock of rooks was feeding and passing singly backwards and forwards to the oaks. On driving the birds away, and walking to the middle of the field, I found hundreds of empty acorn-husks, and a number of half-eaten pecked acorns, which had not had time to change their colour—a cut acorn changes colour on exposure to the air like a cut apple, though not quite so fast. This showed that the birds had been disturbed in the middle of their feast, for the marks on the acorns were quite unlike those made by a rodent or any mammal. They were stabbed and pecked, and the husks were torn off in strips, usually starting from a puncture. It was also noticeable that many of them were not shed acorns, but were accompanied by acorn-cups, the stalks of which had been bitten to tear them off the trees. This was singular, for the ground beneath the trees was covered with shed acorns. The rooks, however, were in the trees, not under them, and the reason for the selection of acorns in cups is probably that they are easier to carry—a shed acorn must be an awkwardly large and slippery thing for a rook's beak, one with a stalk will be more convenient. Several uninjured acorns were found, and most of the remains occurred on smooth spots of short turf—places where a slippery acorn might conveniently be pecked without being lost. One almost uninjured acorn had been driven by a single peck deep into the soft soil of a mole-hill.

It might be thought that it would be much simpler for the rooks to feed on the ground beneath the trees. Some of them apparently do so; but the majority seem always to carry the acorns into the open. The rook is a suspicious bird, quarrelsome, and a born thief. He seems particularly to object to a comrade watching him from any post of vantage, and the rooks when among the oaks, for some reason or other are always quarrelling, notwithstanding the abundance of food. An acorn dropped on rough ground or in a peat-moss would stand a great chance of being lost in some crevice or soft place; but the oak seeds so freely, that the bird need not waste time trying to recover the lost acorn—there are plenty more on the tree.

In this way oak-woods must spread rapidly. But we still want observations as to the distance to which acorns can be carried. I have seen seedling oaks at a distance of a mile from the nearest mature tree (not necessarily the tree from which the acorn came), and have found the characteristically torn husks somewhat further away. Do rooks roosting in elm-trees ever carry home acorns for supper? There used to be a number of rooks which roosted in elms near Brighton in the autumn and winter, but crossed the Downs to feed in the Weald. I have often watched them returning at dusk. Do they ever bring acorns from that distance? This flock may have been responsible for the seedling oaks near the edge of the Downs; and if it could occasionally bring an acorn still further, to Brighton, it is evident that the oak may have crossed the Strait of Dover, when it was somewhat narrower, and that Britain, as far as the oak shows, may have been continuously an island since the Glacial Epoch. CLEMENT REID.

On the Audibility of Fog Signals at Sea.

IN NATURE of August 8, attention was called to some recent investigations, published in *Hansa*, on the inaudibility of fog-horns at sea within certain zones surrounding the signal, although the horn is distinctly heard outside of such regions. It seems strange to me that I can find nowhere suggested that this may be a phenomenon of interference similar to that suggested in light by Dr. Lloyd of Dublin (*Trans. Roy. Irish Acad.*, vol. xvii.).

If we let x equal the distance of the observer from the signal, h and y the heights of the signal and the observer, respectively, above the level of the sea, and δ the linear difference between the paths of the reflected and the direct rays of sound, then

$$x = \frac{1}{2\delta}\left\{\delta^4 - 4\delta^2\,(y^2 + h^2) + 16\,h^2y^2\right\}^{\frac{1}{2}} = \frac{2\,hy}{\delta}$$

approximately. An attempt to apply this formula to the observations recorded in the Report of the American Light-House Board, published in 1894, was foiled by the lack of sufficient data for substitution in the above formula. However, if $h = 100$ ft., $y = 30$ ft., and δ be taken for a wave-length of 2 ft. (which are probable values for the variables), then we would expect minima of sound at 1·1 and 1/3 miles, the maximum between these being at a distance of half a mile from the source of sound, which quantities are of the right order of magnitude. These distances might be modified considerably by refraction, the wind, and to some extent by the tide. When there are two minima, as in the *Hansa* experiments, this seems a much more probable explanation than that by refraction alone generally offered, and it explains the phenomenal loudness outside the silent area. The above equation shows that the boundaries of the silent regions in vertical planes are hyperbolas, which is essentially different from what the refraction theory gives. F. E. FOWLE.

Washington D.C., U.S.A., October 21.

To Friends and Fellow Workers in Quaternions.

IN NATURE for October 3, 1895, there is a letter, signed by P. Molenbroek and Shunkichi Kimura, on promoting the study of quaternions and allied systems of mathematics. I notice that this has not, as yet, been responded to in NATURE. I do not think that the subject should be allowed to drop; but that some permanent good should be done to science by making this branch of mathematics part of the compulsory course of study for students for the highest honours in mathematics in our universities and uuniversity colleges, in the hope that more workers may follow the subject up afterwards.

Unquestionably the calculus is of very great value in the higher natural philosophy, and in every sense will repay the trouble bestowed upon it, though I speak in all meekness and not as an eminent authority on the subject. May we hope for some information as to what form the literature of the International Association will take? G. H. J. HURST.

Eton College, Windsor.

The Colours of Mother-o'-Pearl.

HAD Mr. C. E. Benham given his address when writing to you on this subject (NATURE, vol. lii. p. 619), I should merely have taken the liberty of sending to him direct a copy of a paper entitled, "Prof. Blake and Shell-growth in Cephalopoda" (*Ann. and Mag. Nat. Hist.*, ser. 6, vol. i. pp. 421–427, June 1888), in which similar arguments to those of Mr. Benham were adduced. Now, however, perhaps you will permit me to refer Mr. Benham to Dr. W. B. Carpenter's report on shell-structure (*Brit. Assoc. Rep.*, 1844, p. 11). As for the text-book writers, who usually support their explanation of the iridescence of mother-o'-pearl by reference to the theory of

Brewster, they may be recommended to study his original paper (*Phil. Trans.*, 1814, p. 397), when they will see that such a reading of it is both incorrect and incomplete.

F. A. Bather.

Natural History Museum, October 28.

THE STAR SHOWERS OF NOVEMBER.

Well may Mr. Greg, in his catalogue of meteoric radiants, published in 1876, affix a remark indicating the all-surpassing character of the mid-November meteors. For if there is one star shower more striking than all the rest, it is assuredly the Leonids. Every one who has seen the phenomenon at its best, is prepared to admit that it furnishes a grander spectacle than any other system, and will have realised that, once seen, it impresses itself indelibly upon the memory. There can be very few people living now who witnessed the great shower in America on the morning of November 14, 1833, but there are many Englishmen who vividly remember the fine but less splendid exhibition of 1866. With a swiftness unsurpassed among meteor streams, and with a brilliancy quite their own, the Leonids belong to the most striking class of these bodies, and offer a great distinction to the slow and gentle flights of the Andromedes, or meteors of Biela's comet which present themselves about a fortnight later. It is true the Leonids are only manifested, in vast abundance, once in a generation, and that, considered as an annual display, they usually fall below the strength of the August Perseids. But, considering all things, the November shower is undoubtedly entitled to precedence. The writer saw the Leonids in 1866, he also observed the rich displays of Andromedes in 1872 and 1885, and has been fortunate enough to witness many bright returns of the Perseids and of other prominent systems; but, of all such spectacles, one only, by its surpassing splendour, created an impression which still lives fresh in the memory, and that was the Leonids of November 1866.

The similar display which occurred in 1833, may be regarded as a very auspicious event, since it attracted attention to an important branch of astronomy which had been systematically neglected. Men began to seriously regard a phenomenon capable of giving such a remarkable sky picture, and the facts relating to it were collected and discussed. But the meteor showers of 1833 and 1799 were understood to be very exceptional events, and they had not been observed with that attentive regard to details which is so essential in this class of observation. Astronomers, however, were led to suppose that historical records might contain references to similar phenomena witnessed in ancient times, and Herrick, Quetelet, Arago and others, on consulting old works, found a number of descriptions of star-showers preceding that of 1799, and obviously of the same character. These occurred in 902, 931, 934, 1002, 1101, 1202, 1366, 1533, 1602, and 1698. A list of the dates was given by Prof. Newton in the *American Journal of Science* for May 1864, and he found, on comparing the intervals separating the various returns, that these brilliant meteoric apparitions visited us four times in every 133 years. The descriptions of them were quaint and imperfect, and of little scientific value apart from affording an important clue as to the period of the swarm; but it may be interesting to quote from a few of them. In October 902, a vast concourse of falling stars were scattered over the sky as thick as rain. On October 19, 1202, "stars shot hither and thither in the heavens eastward and westward, and flew against one another like a swarm of locusts; this phenomenon lasted until day-break; people were thrown into consternation and cried to God the Most High with confused clamour." A Portuguese chronicle thus refers to the shower of 1366: "Twenty-two days of the month of October being past, three months before the death of the king Don Pedro of Portugal, there was in the heavens a movement of the stars such as men never before saw or heard of. At midnight, and for some time after, all the stars moved from the east to the west, and after being collected together they began to move, some in one direction, and others in another. And afterwards they fell from the sky in such numbers and so thickly together that as they descended low in the air they seemed large and fiery, and the sky and air seemed to be in flames, and even the earth appeared as if ready to take fire." Coming down to modern displays, Humboldt saw thousands of bolides and falling stars succeed each other during four hours on the morning of November 13, 1799. The phenomenon returned in 1831 and following years, and the facts may be referred to seriatim:—

1831 November 13 a.m. An account of this shower was given to M. Arago by one of the officers of the French brig *Loiret*, as follows: "The sky being perfectly cloudless, and a copious dew falling, we have seen a number of shooting stars and luminous meteors of great dimensions. During upwards of three hours two per minute were seen. One of these meteors which appeared in the zenith left an immense train from east to west, like a luminous band, and the light it gave did not disappear for six minutes."

1832 November 13 a.m. Capt. Hammond, of the ship *Restitution*, then in the Red Sea, off Mocha, says: "From 1 a.m. until daylight there was a very unusual phenomenon in the heavens. It appeared like meteors bursting in every direction. On landing in the morning I inquired of the Arabs if they had noticed the above. They said they had been observing it most of the night, but had never seen the like before."

1833 November 13 a.m. The phenomenon continued during seven hours. At Boston the number of meteors was considered to equal one-half of the flakes which filled the air in an ordinary fall of snow. The number visible was estimated as upwards of 240,000. Another observer stated that between 4 and 6 a.m. about 1000 meteors per minute might have been counted.

1834 November 13 a.m. A large number of shooting stars seen in the United States.

1835 and 1836. Many meteors observed on same date. In the latter year, on November 13 a.m., an immense number of meteors made their appearance between midnight and daylight, but the display did not equal the shower of 1833.

1864 November 13 a.m. An observer on board the steamship *Ellora*, off Malta, wrote on November 14 as follows: "There was a grand display of meteors from midnight to 4h. a.m., all through the watch, the night before last. The watch, an old 'salt' and an intelligent man, said that it was the grandest shower he had ever seen." None were visible on the morning of November 14.

1865 November 13 a.m. Between 1h. and 5h. a.m. 279 meteors were seen by six observers at Greenwich, and it was computed that the total number visible during that period must have been fully 1000. Prof. Herschel noted 71 meteors between midnight and 3 a.m. At Cambridge University 98 meteors were observed between midnight and 2 a.m.

1866 November 14 a.m. 8485 meteors were counted by several observers at Greenwich. Mr. Wood, at Birmingham, estimated that between 1h. and 1h. 30m. a.m. meteors appeared at the rate of 3600 per hour. The maximum occurred at about 1h. 10m. a.m. when Dr. Burder, of Bristol, counted 80 per minute. From the combined observations of several persons looking in different directions, Mr. Lawton, of Hull, made the number of meteors to have been 144 per minute for nineteen minutes from 12h. 58m. to 1h. 17m. a.m.

1867 November 14 a.m. Weather generally unfavourable in England. At St. George, Grenada, there "was observed before day-break a shower of luminous meteors flying about in every direction and of every conceivable magnitude." At the University Observatory, Toronto, four observers counted 2287 meteors between midnight and 6 a.m. Of these 1345 were seen during the hour from 4 to 5 a.m.

1868 November 14 a.m. Many meteors seen in England, but the sky much overcast. At Rome, Secchi reported that 2204 meteors were counted between 2.30 a.m. and 5.45 a.m. At Toronto, Canada, 2886 meteors appeared between November 13 10h. 45m. p.m. and November 14 5h. a.m.

1869 November 14 a.m. Lieut.-Colonel Tupman, at Port Saïd, Lower Egypt, counted 136 meteors between 2.30 and 5h. 14m. a.m., and they were nearly all Leonids. At Santa Barbara, California, 556 meteors were noted by two observers in 2h. 25m. before 3h. 43m. a.m.

In 1870 moonlight partly interfered, but it was evident the meteor shower had lost its conspicuous character—a fact fully confirmed by observations in 1871. But it had not entirely disappeared, for in the years mentioned, and in those which succeeded, the middle of November always brought some of the swift streak-leaving meteors from the well-known radiant in the sickle of Leo.

In 1879 and 1888, on the morning of November 14, very distinct showers of Leonids were observed by the writer at Bristol, and in many other years they were also visible. Mr. Corder, at Bridgwater, saw a few Leonids in 1892, and, in 1893, Prof. Barnard, in California, described them as far more abundant than he had ever seen them before. Many very brilliant ones were seen, and they were especially plentiful on the mornings of November 13, 14 and 15. In 1894 moonlight interfered with observations.

This meteor system evidently forms a complete ellipse, for there seems no reason to doubt that it returns annually without a break. Even in parts of the orbit very far removed from the dense cluster, which seems identical with Tempel's comet (I. 1866), the meteoric particles appear to be pretty numerously distributed, for there were fairly active displays in 1879 and 1888. It is true the shower has not been observed every year, but there is good reason to assume its annual recurrence, and that it would be seen were the nocturnal sky free from clouds and moonlight just at the critical time.

One of the most important features of a meteor shower is that the flights are directed from a common centre, and no observation of such a shower can be regarded as complete unless the radiant point has been determined. The writer has generally found the radiant of the Leonids very sharply defined, and it admits of being accurately detected even by observers who are inexperienced, for the meteors leave luminous streaks, and these, lingering for one or two seconds, enable the directions to be correctly registered. The Leonid radiant has been frequently obtained, and the following are some of the values given by different observers in various years.

1833	November	13 a.m.	148°	+24°	Aiken.
,,	,,	,, ...	150	+20	Olmsted.
1836	,,	,, ...	150	+20	G.O.S. New York.
1865	,,	,, ...	148	+23	A. S. Herschel.
,,	,,	,, ...	148	+23	Newton.
,,	,,	,, ...	148	+24	Marsh.
1866	,,	14 ...	149	+23	Mean of nineteen positions by the best observers.
1867	,,	,, ...	147¾	+23	Bradley.
,,	,,	,, ...	150¾	+22	Watson.
,,	,,	,, ...	148	+23	Harkness.
,,	,,	,, ...	150¼	+22½	Sands.
1868	,,	,, ...	152	+18	Gilman.
1869	,,	,, ...	151	+22	Tupman.
1877	,,	,, ...	146	+26	Backhouse.
,,	,,	11–14 ...	148	+24	Denning.
1879	,,	14–16 ...	147	+23	Perry.
,,	,,	16 ...	151	+22	Sawyer.
,,	,,	12–14 ...	148	+25	Corder.
,,	,,	14 ...	148	+23	Denning.
1880	,,	12–13 ...	148	+22	Sawyer.
1885	,,	15–18 ...	150	+22	Denning.
1887	,,	15 ...	155	+25	Booth.
,,	,,	15 ...	150	+22	Denning.
1888	,,	14 ...	149	+22	Denning.
1890	,,	14–15 ...	151	+24	Backhouse.

In addition to these, some good positions are given in the catalogues of radiants by various authorities, thus:—

November	10–14 ...	148°	+22°	Schmidt.
,,	7–15 ...	153	+22	Greg and Herschel (1863.)
,,	12–13 ...	148	+24	Heis.
,,	11–15 ...	149	+23	Greg (1876).

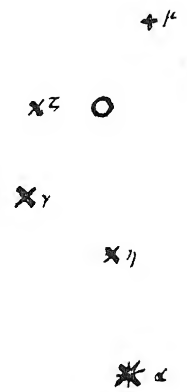
The mean place derived from a large number of positions, agreeing well amongst themselves and individually fixed by the most trustworthy observers, is at

$$149^{\circ}{\cdot}15 + 22^{\circ}{\cdot}9$$

This is almost identical with that of the naked eye star Piazzi IX. 230 (mag. 5·7). the place of which in 1880 was

$$149^{\circ}{\cdot}1 + 22^{\circ}{\cdot}5$$

Relatively to the bright stars forming the sickle of Leo the radiant is situated as in the following diagram:—



Place of the Leonid Radiant amongst the Stars in the Sickle of Leo.

It is of no utility beginning a watch for Leonids before 10.30 p.m., as the radiant does not rise until about that time. It is very rarely that a meteor is seen from a radiant on or a little below the horizon, but a remarkable Leonid was observed in 1879 November 13, as early as 10h. 20m. at three different places, viz. Writtle, Bedford and Bristol. As seen from the latter place, the meteor passed through an arc of 90°, the observed path being from 98° + 22° to 4° − 15°.

The interest in this meteor shower is now rapidly increasing, for we are drawing near the period when brilliant returns may be expected. Two years preceding the maximum, as in 1831 and 1864, we may certainly look for rich displays, so that November 1897 will form an important epoch. It is also in the highest degree probable that in 1895 and 1896 the shower will give decided indications of returning activity. This year the conditions will be very favourable, as the moon, being a slender crescent and within a few days of the new, will be unable to make her influence felt.

The shower of Leonids certainly endures from November 9 to 17, but the really brilliant displays only last a few hours, and these at the end of the present century will occur either on the mornings of the 14th or 15th. 1896 being leap year, the phenomenon may be expected earlier than usual. The year 1898 offers prospective events of extraordinary interest to the meteoric observer, for two brilliant displays may occur within ten days of each other. The Leonids will be due on November 14, and the Andromedes on November 23.

As to the nature of the observations necessary during the progress of a meteor shower, it may be suggested that two persons are required to fully note the features presented. One will record the number of meteors appearing during short intervals, say of five minutes, so

that the time of maximum may be ascertained as well as the aggregate number visible during the period covered by the watch. The other will register the individual paths of well-observed meteors on a star chart or celestial globe, determine the place of the radiant and its character, especially note large meteors and any other peculiarities that may offer themselves. One observer, working single-handed, may do a great deal by dividing his attention between the various points alluded to. It is always important to separate the number of meteors visible in a special shower from the total number seen, for the aggregate counted must exceed the actual strength of a particular stream, since it includes the sporadic meteors. When reckoning the visible meteors, therefore, the observer will do well to keep an account of the number unconformable with the radiant of the main display. The radiant of the Leonids can be readily assigned, not only because of the afterflows or phosphorescent streaks left by the meteors, which assist the eye in fixing their exact directions, but also on account of the well-known asterism involving it. The Leonids exhibit a more contracted area of radiation than the Andromedes, but it is a feature not yet thoroughly investigated. By selecting a number of well-observed tracks near the radiant, the extent of its diffusion may be readily determined. The writer has sometimes found the centre so definite that the conformable paths have intersected at a point.

W. F. DENNING.

THE OLD AND NEW NATURALISTS.

NATURALISTS, like the animals and plants of which they discourse, are subject to the process of evolution. The naturalist of the latter end of the nineteenth century is not quite the same species as that which bore the name at the end of the eighteenth. Differentiation has been at work. So markedly indeed is this the case, that one is tempted to ask whether the species, as such, is not well-nigh extinct. To-day there are biologists, comparative anatomists and physiologists, systematic botanists and systematic zoologists, palæontologists and embryologists. But where is the naturalist? Has he not been swallowed up by and distributed among his polyological progeny? And yet the word is still in use, and carries with it a more or less specialised implication. The other day a friend, who was discussing with me the work of an acquaintance, said: "He's a capital anatomist; it's a pity he's not more of a naturalist"; and I had no difficulty in catching his meaning. It may be worth while to consider the relative position and status of the old and of the new naturalist.

In one of his luminous essays—that on the study of biology—Prof. Huxley reminds us that Hobbes of Malmesbury (Leviathan Hobbes) said: "The register of knowledge of fact is called history. Whereof there be two sorts, one called natural history; which is the history of such facts or effects of nature as have no dependence on man's will; such as are the history of metals, plants, animals, regions, and the like. The other is civil history; which is the history of the voluntary actions of men in commonwealths." In Hobbes's terminology, then, naturalist was synonymous with man of science. Indeed, until quite a recent date, as I am told, the Professor of Zoology in one of our northern universities bore as his technical title the designation Professor of Natural and Civil History. Gradually the field of the naturalist was restricted. Those branches of science which seemed to be specially susceptible of mathematical treatment were allotted to the natural philosopher; the naturalist, as such, continued to deal with physical geography, geology, mineralogy, and the history of plants and animals. The names of Buffon and of Humboldt at once rise to our minds as those of naturalists of this encyclopædic type. But the progress of knowledge, and the vast accumulation of facts, necessitated further division of labour; and by this further differentiation the field of the naturalist was yet further limited to the natural history of animals and of plants. Nor did the process of differentiation stop here. To-day we have herpetologists and ichthyologists; we have zootomists and embryologists; we have systematic botanists and evolutionists; but where, one may again ask, is the naturalist?

I take it that the term "naturalist," as we now use it, implies the sympathetic study of animals and plants in their varied relations to each other under the natural conditions of their customary habitat. In short the naturalist is in great part what Prof. Ray Lankester would call a student of bionomics, or what Semper called an investigator of the higher physiology of organisms. His calling is a protest, first, against the wide-spread error that physiology ends with the individual; and secondly, against the no less erroneous view that science ends with analysis. The naturalist sees in the individual animal or plant merely a constituent unit in a connected whole; and welcomes the most minute analysis chiefly as a means to a more complete synthesis.

Looking back to naturalists of the past in the light of this conception, it is of Gilbert White of Selborne that we feel the term to be exactly descriptive; and in the old days it was the man of leisure like White, the sportsman like St. John, or the angler like Izaak Walton, that was the best and most characteristic naturalist. They started with no equipment of special training, indeed, but with a keen eye, an observant habit, and a generous love of all that ran wild and all that grew free in the face of heaven. They gave their hearts to nature for its own sake; their lavish interest therein had no ulterior motive; they accepted the plain unvarnished tale of creation, and were troubled by no problems of evolution, and in their writings their main object was close, accurate, and sympathetic description rather than reasoned and logical explanation.

Nor can we read the works of the older naturalists without feeling that they were humanists as well. It is true that the more typical humanists of their time regarded their naturalist proclivities in the light of amiable eccentricities, as hobbies with little or no intimate bearing on man, the central figure in all rational and serious study and investigation; little dreaming of the influence natural history was destined to exercise in their own proper sphere of work. But the naturalists were wiser than they knew; wiser perhaps than some modern humanists on the one hand, and some modern naturalists on the other. They included man in their field of view.

Is it too much to say that the connecting link between the old and the new naturalists is to be found in Charles Darwin? The author of the "Naturalist's Voyage" had received but little systematic training, as we now count systematic training; he had the keen eye and the observant habit; he had the generous love for, and sympathy with, nature in all her aspects; he was indeed an encyclopædist in his width of interests, which included physical geography and geology as well as the world of plants and animals; and man was assuredly not absent from his field of view. Is any one likely to question the assertion that Charles Darwin was a great naturalist of the old type? And after more than twenty years of experimenting, investigating, collecting an enormous mass of data, and thinking of the careful patient type which brilliant little bodies even now fail to appreciate, he gave to the world his "Origin of Species," by which the work of all future naturalists was set in a new light. And after that, did he not write his "Orchids," his "Insectivorous Plants," his "Climbing Plants," his "Earthworms," all of them full of the spirit of the new natural history? Had Darwin made another voyage, and had he given us another journal of a naturalist, what we should have

looked for would have been a new description of the animal and vegetable world in their natural relations under the observed conditions of their life, interpreted in the light of the new principles which he himself had gone so far to establish. And this, as it seems to me, marks out the field of work of the naturalist of to-day and to-morrow. He must have grasped the nature of the great biological problems which the latter half of this century has opened up; he must retain the keenness of eye and quickness of observation which characterised the older naturalists; he must deal chiefly in accurate and graphic description, and not too much indulge in speculation—keeping his more speculative work for other modes of presentation; but he must also be to us the interpreter of the facts of animal and vegetable life *as it is lived in the open face of nature*, in terms of recognised principles of biology, and yet wholly without prejudice, forcing no dogma upon nature, expecting daily to discover new truths, and aware of the provisional character of so many of the conclusions of the evolutionist.

If then we attempt to define the naturalist, we may say: first, that his subject-matter is animate nature as it is; the inter-relations of living things in the web of life, the bionomics or higher physiology of organisms. Secondly, that his method is primarily observational; but that, if the synthetic picture is to be achieved, he must be aware to the full of the results of analysis in physiology, psychology, and ætiology. And thirdly, that his mood must be sympathetic, and that to be successful in his presentation he must combine the qualities, not only of the man of science, but also of the artist.

While much admirable and fascinating work has been done by traveller-naturalists in many parts of the world, it must be remembered that there is abundant work for the stay-at-home naturalists in the ponds and hedgerows, woods and shores, of our own country. The members of our field-clubs may do excellent service to the general cause of natural history. But, without denying the value of cataloguing the local faunas and floras, we must recognise that many field-clubs and naturalists' societies err in confining themselves too exclusively to this. Precise observations as to the habits of animals, and the environmental relations are needed even more urgently than systematic work of this kind.

And here a word or two may be said on "Natural Histories." Most of the natural histories of animals have not sufficiently shaken themselves free from the bondage of the systematist. They are to a large extent hybrid works with a foundation of more or less popularly expressed systematic zoology, and sections or paragraphs on habit and instinct. Brehm's "Tierleben" is, however, a treasure-house of observations as to the life and habits of animals to which Darwin and many others have freely acknowledged their indebtedness, while others have not. The "natural history," as such, should have for its primary subject the inter-relation of animals and plants, the web of life as it is presented to our study; and to this all reference to anatomical structure, systematic position, and individual habit, should be made subsidiary. In botany, Kerner's great work, a translation of which by Prof. Oliver is now published, affords an admirable example of what a natural history should be. The bionomic note is here distinctly dominant.

Of course under the new conditions of the present time the preliminary training of the naturalist needs to be both wider and fuller than was either possible or necessary for the older naturalists. He must be not only well read in, but must have real practical acquaintance with, physiological and biological investigation. There is, moreover, one point in connection with the preliminary training of the naturalist which appears to me to be important. In his description of animal life he will have to interpret many of their actions in terms of the underlying mental processes. To do this with any success he should have a training in psychological methods. Such training has been too much neglected in the naturalists of the past; and even now it is often assumed, or so it would seem, that whereas when biological problems are concerned, the guidance of untrained mother-wit is, by itself, scarcely adequate, yet, when psychological problems are concerned, this is amply sufficient.

That his work may be effectual, the naturalist should be not only a man of science but a man of letters. This will give to his interpretation a special value. But he must be both in equal degree. He must not, as is too often the case with magazine writers, regard natural history as merely a subject on which may be written a certain number of bright and pleasing pages which shall not require any undue amount of exercise of thought on the part of his readers. Not that in saying this I would utter one word in disparagement of such writers as Kingsley, Jefferies, and Burroughs, of Mr. Warde Fowler, and a number of keen observers who have made their observations the subjects of delightful essays. Nay, rather I would contend that these writers have done good service in illustrating the value of the sympathetic mood, in emphasising a healthy reaction against "mere necrology," in vindicating the right of the amateur to contribute towards the end all naturalists have in view. But I still feel that, for the naturalist as such, his first and foremost object must not be to give us pleasure by his manner and method, by his delicacy of touch and his imaginative treatment; it must rather be to tell us something which in and for itself is worth knowing, since it will give us a deeper and truer insight into the world of living things. Literary finish, grace of style, imagination and graphic power should be there; but this should be like the cutting and polishing of the gem which, though it enhances its value, does not by any means constitute the chief element thereof.

The species naturalist, then, is not dead but liveth. It includes not only the professional, but the so-called amateur. The naturalist has been of late in La Plata, in Borneo, in Celebes; he has told us of the wonders of animal life on the ocean surface; he has watched the struggle for existence in a tropical forest and on the sea-shore; he is at work among aquatic insects, and learns the ways of birds and insects on Bindon Hill; he knows not only the zoology but the natural history of rotifers, and can discourse delightfully to the Royal Microscopical Society on the unnecessary difficulties in the way of studying natural history; and he still looks out across the waters of Poole Harbour to Corfe Castle, and tells us of the days of his youth in the Malay Archipelago.

In conclusion we may say that just as the early poets were frankly and naïvely descriptive, so too were the early naturalists. Neither dealt in deep and subtle analysis. But the time of analysis came and flooded the world. The modern poet profits by all this analysis, is indeed a subtle analyst himself; but, as poet, he keeps his analysis out of sight, and gives us a new presentation of nature in descriptive and synthetic form. So too must the modern naturalist profit to the full by all the biological and psychological analysis of his times; but, as naturalist, he must keep all this out of sight, and give us a new presentation of animal and vegetable life in descriptive and synthetic form. And he must remember that his picture will not be complete unless it include man himself. For man is also in the web of life, influencing and being influenced by all around him; nowise to be ignored, but to be taken account of to-day as he was by Humboldt, and by the stronger naturalists of the old school. And this new descriptive presentation of nature, as it reveals itself to the eye and brain of the modern naturalist, will differ chiefly from that of his predecessor, first, in that it is no longer a piece of amiable eccentricity, but is in close touch with the

gravest problems that man has to grapple with; and secondly, in that it has more or less distinct reference to a past of which the present is but an outcome and a development. C. LLOYD MORGAN.

HERMANN HELLRIEGEL

PROF. HERMANN HELLRIEGEL, whose death took place at Bernburg, Anhalt, on September 24 last, was born at Pegau, Saxony, on October 21, 1831, so that he was within a month of completing his sixty-fourth year. His life, on the whole, was uneventful, for he devoted himself with studious zeal almost entirely to investigations, both chemical and physiological, into the phenomena of plant nutrition. One of his earliest official posts was that of Director of the Agricultural Experiment Station at Dahme, in Brandenburg, which was founded in 1857 by an association of agriculturists in Jüterbog-Rückenwalder. During his tenure of this post he studied experimentally the alimentary needs of certain plants which are cultivated as field crops, notably cereals, potatoes, and sugar-beet, his method involving the use of sterilised soil, both by itself and with the addition of various chemical salts. His physiological inquiries embraced observations on the growth and development of roots, on the quantity of water used in the growth and maturation of field crops, and on the minimum amounts of nitrogen, phosphoric acid, potash, and other ingredients required by plants. Supplemented by observations on crops grown in the open field, these investigations led Hellriegel to conclusions of great practical importance, notably in connection with sugar-beet, a crop which Germany grows more extensively than any other European country, its annual average area for the last twelve years having been 800,000 acres, or more than one-fourth of the entire European acreage.

It was with no little regret that in 1873 Hellriegel gave up his directorship at Dahme, though for a post with greater emoluments. But his capacity as an investigator had made its mark, and when in 1882 the Verein für Zucker-Industrie, in co-operation with the Government of the Duchy of Anhalt, established an experimental station at Bernburg, for the special investigation of problems bearing upon the cultivation of sugar-beet, it was felt that Hellriegel possessed special and peculiar claims to the directorship, which was accordingly offered to him. He accepted with avidity a post which enabled him again to devote his time and energy solely to those investigations into plant-life, which had previously exercised upon him so strong a fascination. The station at Bernburg is admirably equipped, and Hellriegel found himself in a position to at once resume his inquiries into the nutrition of leguminous plants, a subject that had previously received his attention at Dahme. It was here that after a dozen years' work he, in collaboration with Dr. Wilfarth, made the great discovery with which his name will ever be inseparably associated, namely, the capacity of leguminous (or at least of papilionaceous) plants to take up, or fix, through the agency of the micro-organisms of their root-nodules, the free or uncombined nitrogen of the atmosphere.

The intimation—the revolutionary announcement—of this startling discovery was made on September 20, 1886, in a communication to the Naturforscher Versammlung, held at Berlin, and over the agricultural chemistry section of which Dr. (now Sir Henry) Gilbert happened to be presiding—a coincidence of exceptional interest in view of the circumstance that Sir Henry Gilbert was one of the joint authors of the celebrated memoir by Lawes, Gilbert, and Pugh, "On the sources of the nitrogen of vegetation, with special reference to the question whether plants assimilate free or uncombined nitrogen" (*Phil. Trans.* 1861), which, at the time of its appearance, and for long after, was regarded as setting at rest the question as to the capacity of plants to assimilate the free nitrogen of the atmosphere, and of confirming upon this point the negative results previously obtained by Boussingault. Hellriegel's momentous discovery furnished an explanation of the long-known fact that a clover-crop leaves the soil richer in nitrogen than it finds it, and is therefore a suitable crop to precede the wheat-crop in a rotation, clover being—as we now understand through Hellriegel's discovery—a nitrogen-accumulating plant, and wheat a nitrogen-consuming one. Indeed, the fact itself is a very old one, for it was observed by the farmers of the Roman Republic that beans, lupins, vetches, and other plants belonging to the sub-order Papilionaceæ, as now defined, rendered the soil "more fruitful" for the crops that followed. But nearly 2000 years elapsed from the time when Varro recorded this, to that when Hellriegel, a brief nine years ago, supplied the explanation. It in no way detracts from the value and significance of the discovery that Hellriegel and Wilfarth should have happened upon it in the course of investigations which were really directed to quite a different object. Those who devote their lives to research are not unaware that gems, hitherto unseen, may sometimes be picked up on the wayside.

We have spoken of Hellriegel's discovery as revolutionary, and it certainly upset a long-cherished belief. The opposition which his announcement received at the outset was a testimony to its importance. Subsequent research, both in Europe and in North America, has, however, only strengthened the position which Hellriegel took up, whilst it has suggested new lines of investigation for which there will probably be no lack of workers. Bréal, Frank, Hiltner, Lawes and Gilbert, Schlœsing fils and Laurent, are but a few of the investigators who have proved the accuracy of the discovery made at Bernburg. In recognition of his work, Hellriegel was elected an honorary member of the Royal Agricultural Society of England, a rare distinction, which he enjoyed in common with such continental workers as Pasteur, Fleischmann, and Chauveau. In France his merits were recognised by his election as a foreign associate of the Société nationale d'Agriculture, and as a Correspondant of the Academy of Sciences.

NOTES.

THE German committee for the exploration of the South Polar regions met at Berlin on Sunday, and decided to send two vessels southwards from Kerguelen Island, leaving full liberty of action to the leaders. The total sum to be allotted for the expedition, which is to last three years, has been fixed at 950,000 marks (£47,500).

CHICAGO UNIVERSITY continues to be the recipient of Fortune's favours. Mr. John D. Rockefeller has (says the New York correspondent of the *Daily Chronicle*) added £200,000 to his previous gift of £800,000 for the endowment of the Chicago University. He promises £400,000 more if any one else will subscribe a like sum. When will the day come for such generous gifts to education and research in England?

THE Municipal Council of Arbois, the birthplace of Pasteur, has decided to erect a statue to his memory, and also to call the municipal college the Pasteur College.

M. BERTHELOT, the distinguished chemist, has been appointed Minister of Foreign Affairs in the new French Cabinet. He was Minister of Education in the Cabinet of 1886-87.

IT is reported that the Paris Municipality have granted £800 to the Salpêtrière Hospital for the erection of new buildings in which to treat nervous and mental affections by electricity.

THE Board of Agriculture have appointed a Departmental Committee to consider and report upon the arrangements which it is desirable to make for the sale and distribution of Ordnance Survey maps. The committee consists of the following gentlemen:—Mr. W. Hayes Fisher, M.P. (Chairman), Mr. H. Hobhouse, M.P., Mr. W. A. M'Arthur, M.P., Mr. F. a'C. Bergne (Treasury), and Mr. T. H. Elliott (Secretary to the Board). Mr. J. J. Thomson, of the Board of Agriculture, will act as the Secretary to the Committee.

THE new public museum which has lately been opened at Kasan, well deserves the attention of archæologists for its beautiful collections, the gift of A. Th. Likhacheff. The collections comprise a considerable number of golden and silver bracelets, earrings, rings, as well as of various arms and implements from the once powerful kingdom of the Volga Bulgars, on the seat of which Kasan now stands. The modern decorative art of the Kasan Tartars, as well as the dress and implements of the Chuvashes, Cheremisses, and Mordves, are also very well represented; while nearly 1500 stone implements illustrate the Stone age on the Volga and the Kama.

THE Zoological Department of the British Museum (Nat. Hist.) has recently acquired (by purchase) an important series of British fossils from the cabinets of the Rev. P. B. Brodie, of Rowington, Warwickshire. The specimens mainly illustrate the fauna and flora of the Mesozoic period, among them being several valuable types described by Owen, Egerton, Buckman, Wright, Duncan, Carruthers, Woodward, and other palæontologists. Some of the rarer genera include remains of *Hyperodapedon*, *Mastodonsaurus*, and *Cladyodon* from the Keuper sandstone of Warwick, each of which will be now represented in the National collection for the first time, from that locality.

IN September of next year, the Smithsonian Institution, which has exerted an immense influence upon the development of science in America, and which has done more than any institution to make the results of scientific work known unto the ends of the world, will celebrate its jubilee. It is stated by Dr. Brown Goode, in a historical account of the Institution, that a special volume will be published to commemorate the event, and two memorial tablets will be erected in honour of the founder in the city of Genoa, where he died June 26, 1829: one in the English church, and one upon his tomb in the beautiful little English cemetery on the heights of San Benigno.

REUTER reports the occurrence of a severe and prolonged earthquake shock in Rome at 4.30 on the morning of November 1. The Central Meteorological Bureau states that the movement of the earth began with very slight tremors, lasting from four to five seconds. Subsequently a series of strong shocks, which continued for nearly eight seconds, occurred. After a calm of a few seconds slight undulations were perceptible for about eight seconds. Two clocks in the observatory stopped, and the old tower of the Roman College was cracked a little. At Rocca di Papa, near Rome, a violent undulatory shock was felt at 4.40. It lasted seven seconds, but caused no damage. Shocks were also felt at Anzio, Velletri, Tivoli, Civita Vecchia and Fiumicino, all in the vicinity of the capital. At the latter place the earth movement was especially strong.

WE have received from Prof. G. Vicentini, of Padua, some interesting copies of microseismographic records of a distant earthquake on October 20. The instrument with which they were obtained has been briefly described in a previous note (vol. li. p. 540). The first movements, which Prof. Vicentini attributes to longitudinal waves, began about 9h. 30m., Greenwich mean time (whether a.m. or p.m. is not stated), and lasted about twenty minutes. The second series of pulsations, which he regards as due to transversal vibrations, and each of which had a period of about thirty seconds, attained their maximum intensity about 10h. 15m., and lasted until about 11h. 30m. Somewhat similar pulsations were also registered on October 4, the longitudinal vibrations commencing between 10h. 25m. and 10h. 30m., and the transversal vibrations (of long period) after 10h. 50m. So far as we are aware, no great earthquakes are known to have occurred on these days. If the disturbances are of seismic origin, they must evidently be due to very violent shocks taking place in some distant region of the globe.

THE death is announced of Dr. Albert E. Foote, of Philadelphia. Dr. Foote was born at Hamilton, in 1846. After graduating at Courtland Academy, Homer, N.Y., he entered the class of 1867 in the University of the State of Michigan, where he took the degree of Doctor of Medicine. He spent some time as an instructor at Ann Arbor, and also as Assistant Professor of Chemistry and Mineralogy in the Iowa State College. He removed to Philadelphia in 1875. He was a life member of the Academy of Natural Sciences, of the New York Museum of Natural History, and the American Association for the Advancement of Science. Dr. Foote's wide correspondence and extended travels made him well known, especially among mineralogists. His exhibits and lectures at the American Exhibition in London in 1887, and attendance at the meetings of the British Association in several years, established lasting relations with many English mineralogists. He was one of the most enthusiastic and successful of collectors, and found much of the enjoyment of life in the collection and study of minerals and meteorites.

THE *Pioneer Mail* of Allahabad is always to the front when the claims of science to a fuller recognition in India have to be urged. A leading article, in its issue of October 10, calls attention to the need for a better recognition of scientific research than at present exists there. "Buried in the archives of the Asiatic Society of Bengal," remarks our spirited contemporary, "in those of the kindred British societies, and in a few journals of the elect, is a mass of scientific literature relating to the Anglo-Indian Empire with which its Government professes to have no concern. Most of this literally priceless work has been done by Government officials in such leisure as they have been able to snatch from the daily turn at the Government mill. The Civil Service has been rich in amateur 'pandits,' but their fame is not echoed from the rocks of Simla, though it resounds in European halls of learning. In India such men were looked at askance by the Bureaucracy, and relegated to desert places. Years ago the State spoilt an excellent geologist by converting him into a Government gardener, and did the same for another by gazetting him an ornithologist. And all the while there is that great mine of palæontological wealth in the Sewaliks lying fallow since the days of Falconer—the far-away time of Cautley and the Ganges Canal. In a few cubic feet of worm-eaten Government reports are to be found the bald details of measurements which represent the Government knowledge of Indian archæology. No one has followed in the footsteps of Fergusson; his monumental work is a classic alongside with the unopen and dust-laden works of Todd in Rajasthan and many another amateur. Not very long ago Government nipped in the bud any inclination on the part of their little Geological Department to travel into regions other than those of purely economical geology. Now that General Cunningham is no more, that sole key to the history of ancient India—numismatics—would speedily rust and be lost were it not for the enthusiasm of an amateur, who is left to struggle along as best he can. A noble effort, but a lasting reflection, nevertheless, upon an enlightened Government."

EFFORTS are being made to obtain funds for the erection of a memorial to the memory of the late Joseph Thomson, the African explorer. Subscriptions may be sent to Mr. S. W.

Silver, 3 York Gate, Regent's Park, or to Mr. J. Scott Keltie, 1 Savile Row, Burlington Gardens.

A FEW particulars with reference to the Pasteur Institute, from the *British Medical Journal*, are of special interest at the present time. The receipts budget of the Institute is as follows:—The interest on £48,000, which is the amount that remains of the ublic subscription (about two-thirds of the sum subscribed, or £80,000, was spent on the ground bought for the Institute and in building). From £800 to £1200 was granted by the Minister of Agriculture in recognition of the service rendered by the anthrax vaccine, by the treatment of swine fever, and by the supply of tuberculin and mallein. A subvention is granted the Minister of Public Instruction to pay the salaries of such of the Institute staff as were formerly attached to Pasteur's laboratory. Certain profits are made by the sale of the anthrax vaccine, and others sold at a very low price to veterinary surgeons, and they realise for the Institute an income of £800. The fees paid by the pupils who attend the lectures of the Institute are also paid into the Institute treasury. Dr. Roux's antidiphtheric service is annexed to the Pasteur Institute, but has a distinct budget. This service is organised at Garches, on the estate given by the Government to M. Pasteur for the purpose of carrying on his researches on rabies. Its revenue is furnished by the interest on the sum realised by a public subscription, and by a Government grant amounting this year to £3200. The services at the Institute are as follows:—Practical services, consisting of inoculations, &c.; the lectures in this service are given by Dr. Roux and Dr. Metchnikoff. The pupils are of two classes, "hearers" and "workers," who are allowed to work in the laboratories. The research laboratories are placed at the disposal of investigators, whose communications are published in the *Annales de l'Institut Pasteur*. The chiefs are—M. Duclaux for biological chemistry; M. Grancher, M. Charrin, and M. Chantemesse for rabies; M. Chamberland for microbic vaccinations and practical applications. There is a morphological laboratory under the direction of M. Metchnikoff, and a technical one under M. Roux. M. Nocard, professor at Alfort Veterinary School, directs a veterinary service annexed to the Institute. M. Duclaux is professor at the Faculté des Sciences. The course of lectures he previously gave at the Sorbonne are now held at the Pasteur Institute, where the Sorbonne pupils follow him. The Institute was founded in 1888, and retains its constitution and characteristics notwithstanding the death of Pasteur. His pupils will carry on the work.

THE late Mr. John Bell Sedgwick has bequeathed £300 to the Royal Institution in aid of the fund for the promotion of experimental research at low temperatures; and Sir Frederick Abel has given £50 to the same fund.

THE Manchester Museum public lectures continue to attract large audiences. This year there are five courses, each consisting of three lectures; and the first course was brought to a close on Saturday afternoon by an interesting discourse upon "Social Customs and Dwellings," the general subject being "The Elements of Anthropology," and the lecturer Prof. S. J. Hickson. The succeeding lectures are upon Mineralogy, by Dr. Burghardt; Botany, by Prof. F. E. Weiss; Geology, by Prof. Boyd Dawkins; and Zoology, by Mr. W. E. Hoyle. There are now seven handbooks upon the various departments of the Museum, one of which—a handy guide to the whole of the cases—is sold for a penny. The aim of the Professors is to render the lectures educationally valuable, as well as interesting; and the hands of the authorities will be strengthened by a recent grant from the Manchester Corporation of £400, which is to be annual.

THAT certain Hymenoptera and Homoptera secrete wax is well known, and a note by Dr. H. G. Knaggs, in the *Entomologist's Monthly Magazine* for November, indicates that this function can also be performed by Lepidoptera. An investigation of some cells of *Retinia resinana* proved them to contain a very appreciable amount of wax, which formed the lining of the cells. The nature of the lining was demonstrated by dissolving off the resin by immersion in cold rectified spirit, a fluid which appears to have little or no effect upon the wax, so that the latter was thereby exposed to view. "From this it seems to me," concludes Dr. Knaggs, "to be pretty clear that the larva is furnished with the power of secreting wax for the purpose of protecting itself from contact with the tenacious semi-liquid resin exuding from the wound in the fir bud; otherwise, it would inevitably become involved in the sticky medium. Previously to this, however, I was aware that the imagines of certain Lepidoptera contained wax, though I had then formed no idea as to the part played by it in the economy of the insect's life."

GOLD-MINING is showing signs of revival in Victoria, as in many other countries. Forty years ago the colony was the foremost gold-producer in the world, throwing even California into the shade. Although, however, its output has shrunk from over 3,000,000 ozs. in 1856 to 673,000 ozs. last year, it has now, according to the *Annual Report of the Secretary for Mines*, again become a progressive quantity, and the product in 1894 was greater than that in any previous year since 1885. This was due to exceptional causes, the granting to the unemployed of free passes by railway from Melbourne to the various gold-fields having added 15,000 labourers to the number of prospectors and "fossickers." Quartz-mining was less actively pursued in 1894 than in 1893, and the whole gain came from alluvial deposits. Of these, as usual, the most important were the "deep leads" or gravels contained in the beds of Pliocene streams now buried beneath lava flows. In Victoria these gravels are almost exclusively reached by shafts, the deepest of which, at Bendigo, is now down 3122 feet. The Government geologist reports that some extensive systems of deep leads have been discovered and traced out by borings, one system in particular, on the northern side of the Great Dividing Range and to the westward of the meridian of Melbourne, having an aggregate length of forty miles of leads. To work this an enormous capital would be required, and it is proposed to make it a national undertaking, subsidised by the Government.

A VALUABLE paper on the new rubber industry in Lagos appears in the Kew *Bulletin* of Miscellaneous Information (No. 106, October), from which source the following facts were obtained. It is well known that in West Africa there are numerous plants yielding commercial rubber. The chief of these are species of the Apocynaceous genus *Landolphia*, consisting of climbing shrubs, with stems four to six inches in diameter dividing above into numerous branches, and supporting themselves on neighbouring trees. From these, and similar plants, a very important rubber industry was started at the Gold Coast by Sir Alfred Moloney, K.C.M.G., in 1882; and although previous to that year no rubber whatever was exported from that colony, it had attained in 1893 to the annual value of £200,000. This is a remarkable and striking instance of the creation of a new industry by official action, and it deserves to be recorded. In 1882, Sir Alfred Moloney pointed out the possibilities of a similar rubber industry in Lagos, and suggested "the adoption of measures having for their object the addition of one more to the industries of the colony." The result of this was not immediately apparent. But in 1894 the present Governor of Lagos, Sir Gilbert T. Carter, K.C.M.G., induced a party of natives from the Gold Coast, experienced in rubber collecting, to go to Lagos to develop this valuable and importan industry. A new rubber-yielding tree, the native name of which is "Ire" or "Irai," was shortly afterwards discovered

to be abundantly distributed in the interior forests of the colony. The tree has been identified at Kew as *Kickxia africana*, Benth., and the history of its discovery, and the remarkable influence it has had upon the rubber industry, is full of interest, and illustrates the wonderfully rich resources of the forests of West Africa. The account also shows very clearly how these resources can be developed by judicious and intelligent action on the part of the Government.

A SPECIAL feature of the recent meeting of the British Association at Ipswich was the consideration given to agriculture and allied subjects. As already reported in our columns, a joint sitting of the Sections of Chemistry and Botany was held for the purpose of discussing the relations of agriculture to science. The discussion was opened by Prof. Warington, who read a paper on this subject. Mr. J. Hendrick, of the Glasgow Technical College, and Mr. M. J. R. Dunstan, the Director of Technical Education for Nottingham, also sent papers by way of contributions to the proceedings. One very good feature of this organised discussion was that copies of the opening paper had been freely circulated some time before the meeting, so that the speakers were prepared for the mode of treatment which Prof. Warington adopted. If this plan were more generally followed when discussions at joint sectional sittings were to be held, the value of such meetings would be greatly raised. In response to a widely-expressed desire, the three papers referred to, and a condensed report of the remarks made by the various speakers, have now been reprinted in pamphlet form, and can be had, at a trifling cost, from the Secretary of the British Association, Burlington House, or from the office of the *East Anglian Daily Times*, Carr Street, Ipswich. All who are interested in the agricultural question, from the educational or from the scientific side, will find much material for serious consideration in the various views expressed by a series of speakers of recognised authority.

DR. SIMPSON, Health Officer in Calcutta, in his annual report, refers at some length to Prof. Haffkine's anti-choleraic vaccinations, and expresses himself as very favourably impressed with the treatment, as far as can be judged at this early stage of the inquiry. Some interesting facts are quoted relative to the manner in which the progress of cholera in particular houses seemed to be arrested by inoculation. Thus, in one instance cholera attacked fatally one member of a household; two days later, eleven members of the family out of eighteen were inoculated. "It so happened," continues Dr. Simpson, "that cholera again breaking out in the house, attacking four persons, three of whom died, selected four of the seven not inoculated, while the eleven inoculated remained perfectly free." Again we read that two fatal cases of cholera and two of choleraic diarrhœa occurred in Katal Bagan Basti in a population grouped around the tanks. This outbreak led to the inoculation of 116 persons in the district out of about 200. Since the 116 cases were inoculated, nine more cases of cholera, of which seven were fatal, and one case of choleraic diarrhœa took place. All these ten cases of cholera occurred exclusively among the non-inoculated portion of the inhabitants, and not one of those treated with the vaccine were affected. Dr. Simpson recommends the Commissioners to give the system an extended trial, and he considers that such observations, if carried on in Calcutta on a large scale in its most affected parts during the next one or two years, would solve the question as to its efficacy. As regards the discomfort caused by the inoculations, he states that it is on the whole milder and of shorter duration than that of vaccination against small-pox. Two vaccines are used, one mild and the other strong, and for a complete vaccination two inoculations are necessary, first with the mild vaccine, which produces some pain at the seat of inoculation, or discomfort and fever for about one day; after a period of five days the second inoculation takes place with the stronger vaccine, which produces a similar form of malaise to that caused by the first inoculation. The harmlessness of the treatment has been established beyond question.

As one of the results of a long piece of work carried out in the botanical laboratory of Trinity College, Dublin, Mr. Henry H. Dixon believes that his preparations of the pollen-mother-cells of *Lilium longiflorum* before their first division show that origin of the double nuclear thread is not from the cleavage longitudinally of an originally single thread, but from the approximation of portions of the single thread, so that these portions come to lie more or less parallel to one another. When the thread breaks into the chromosomes the divisions affects both portions, so that each chromosome is composed of two more or less parallel pieces. These pieces may lie side by side, or may be fused together at one end while the other ends are somewhat parted asunder, or they may be bent in such a manner that they come to lie across one another in two or three places, or they may be fused together at both ends. As the chromosomes arrange themselves in the equator they become shorter and thicker, and they are so disposed that the plane of separation between their two parts lies vertically, and consequently they appear double when viewed from the polar aspect. At this stage, when seen from the equatorial plane, they have the appearance of short thick rods. Later on, horizontal fission takes place in each, beginning from the inner end. As this proceeds they assume the T-shape described by Belajeff. The daughter chromosomes have the V-shape as they leave the nuclear plate, having passed through stages similar to those described by this author. As they approach the poles each V-shaped chromosome cleaves transversely at the angle, and breaks into two short straight rods, so that at the poles there appear to be twice as many chromosomes as in the nuclear plate. Thus it appears probable, both from the origin of the two portions of the chromosomes forming the nuclear plate, and the subsequent division of the daughter chromosomes at the poles, that each chromosome of this mitosis corresponds to two chromosomes of previous nuclear divisions fused more or less completely end to end. The division following, to form the pollen-tetrads, was not observed in this plant, but it probably conforms in its details to the normal karyokinesis in plant cells, as in *Lilium Martagon* and *L. chalcedonicum* it was followed, and the normally-proportioned chomosomes undergoing longitudinal fission in the nuclear plate were observed.

A LONG paper on the working of iron and steel, by M. E. Demenge, appears in the *Revue Générale des Sciences* for October 15 and 30. The article is illustrated by twelve full-page plates, chiefly representing modern forging and rolling machinery.

IN *Botany Bulletin*, No. 11, of the Department of Agriculture, Brisbane, Mr. F. M. Bailey gives a complete list of the Freshwater Algæ of Queensland, including descriptions of several new species.

MR. G. MASSEE has reprinted from the *Annals of Botany* his paper on the "Spot-disease of Orchids," which shows that the disease is not of a parasitic nature, the initial cause being the presence of minute drops of water on the surface of the leaves at a time when the temperature is exceptionally low and the roots copiously supplied with water.

WE have received a further communication from Mr. Radcliffe, the inventor of the "38" puzzle (NATURE, No. 1352, p. 525), in which he shows how, by the sacrifice of his three extra symmetrical arrangements, the maximum number of 15 straight lines (all totalling to 38) can be obtained. He points out also some other symmetrical arrangements.

THE first edition of "Practical Physiology of Plants" (Cambridge University Press), by Mr. F. Darwin, F.R.S., and Mr. E. Hamilton Acton, was published a year ago. The work has been appreciated from the outset, and so great has been the demand for it that it has been out of print for a little time. A second edition has, however, just been published; but with our pleasure that the merits of the book have been recognised, must be mingled regret that the death of Mr. Acton should have prevented him from seeing its success.

THE forthcoming number of the *Physical Review* (November-December) will contain the following articles:—"Variation in Electric Conductivity of Metallic Wires in Different Dielectrics," by Fernando Sanford; "A Study of the Polarisation of the Light emitted by Incandescent Solid and Liquid Surfaces" (II.), by R. A. Millikan; "On Ternary Mixtures" (III.), by W. D. Bancroft; "On the Changes in Length produced in Iron Wires by Magnetisation," by L. T. More. Among the minor contributions will be: "The Limits of Pitch for the Human Voice," by W. Le Conte Stevens; "The New Physics Laboratory at Lille," by E. L. Nichols.

THE *Quarterly Journal* of the Geological Society (No. 204, November), just published, is illustrated by twelve plates. The contents of the number include a paper on the geology of Mount Ruwenzori and some adjoining regions of Equatorial Africa, by Mr. G. F. Scott Elliot and Dr. J. W. Gregory. Mr. A. Strahan explains overthrusts of Tertiary-beds in Dorset, and Mr. G. W. Lamplugh describes the "Crush-Conglomerates" of the Isle of Man, while Mr. W. W. Watts writes on the petrography of the same. The other authors and papers are: Messrs. W. Hill and A. J. Jukes-Brown, on the occurrence of Radiolaria in Chalk; and Dr. G. J. Hinde and Mr. H. Fox, on Radiolarian rocks in the Lower Culm Measures.

THE Meteorological Council have published the hourly means of the readings obtained from the self-recording instruments at the five observatories under their control, for the year 1891. The present volume contains the values for an additional observatory—Fort William, the low-level station of the Ben Nevis Observatory. An additional table has also been added to the series, containing hourly sunshine values, and in an appendix will be found the results of an hourly tabulation of the sunshine cards for the ten years 1881–90, for seven stations, illustrated by coloured plates. A summary of the hourly and seasonal variation of sunshine, based upon these values, was submitted to the Royal Meteorological Society, by Mr. R. H. Curtis, on June 19, a report of which appeared in our issue of the 27th of that month (p. 215).

IN connection with the recent jubilee celebrations at the Royal Agricultural College, Cirencester, which were attended by the Prince of Wales, as patron of the institution, a special effort was made to issue a number of the *Agricultural Students' Gazette* which should be worthy of the occasion. Several past professors of the college responded to the editor's call for co-operation, and accordingly we find articles on "Anbury, Club-root, or Finger-and-toe," by Mr. W. T. Thiselton-Dyer; on "The Rise and Progress of Veterinary Science in its Relation to Agriculture," by Prof. G. T. Brown; and on "Meadows and Pastures," by Dr. W. Fream. Old students are represented by Sir Jacob Wilson, who writes on the "Progress of Agricultural Education." Prof. Warington has a paper on "Organisms in Soil assimilating Nitrogen from the Atmosphere"; and amongst other subjects dealt with are the breeding of Shires, our meat supply, estate fences, curd making, chlorine in rain-water, and Samuel Hartlib and his "Legacie."

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mrs. Jackson; three Red-backed Pelicans (*Pelecanus rufescens*) from East Africa, presented by Mr. F. E. C. Remington; two Verticillated Geckos (*Gecko verticillatus*) from Burmah, presented by Mr. H. Champion; a Common Boa (*Boa constrictor*) from South America, presented by Mr. F. J. Mitchell; a Whimbrel (*Numenius phæops*), European, presented by Messrs. Mason; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, a Brown Capuchin (*Cebus fatuellus*) from Guiana, deposited; two Black-tailed Flower-Birds (*Anthornis melanura*) from New Zealand, two Silver Pheasants (*Euplocamus nycthemerus*) from China, purchased; a White-tailed Gnu (*Connochætes gnu*, ♂) from South Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

STARS WITH BRIGHT AND DARK HYDROGEN LINES.—In his observations of the spectrum of the well-known bright line star γ Argus during 1893–94, Prof. Campbell noted the remarkable fact that whilst the red line of hydrogen was quite bright, the hydrogen lines in the violet were dark. The same peculiarity was also observed in the spectrum of η Tauri.

Since then Prof. Campbell has observed the spectra of all the available stars showing the F line bright in their spectra, and in some cases has secured successful photographs; from a consideration of the results obtained, he claims to have established the following points. (1) Some stars contain both bright and dark hydrogen lines. (2) The bright lines in such stars are those of greater wave-length, the dark lines are those of shorter wavelength. (3) The intensities of the bright lines decrease as we approach the violet. (4) The intensities of the dark lines increase as we go to the violet. (*Astrophysical Journal*, vol. ii. No. 3, p. 177).

In the case of γ Cassiopeiæ, Prof. Campbell finds the bright hydrogen lines to diminish very rapidly in intensity in the more refrangible part of the spectrum, and observes that they are situated within broad dark hydrogen lines; he does not, however, appear to have noticed the additional feature of the duplication of the bright lines in the spectrum of this star as photographed at Kensington (NATURE, vol. li. p. 425), although he records a similar appearance in the spectrum of ϕ Persei.

As to the explanation of the somewhat strange behaviour of the hydrogen lines, Prof. Campbell revives a suggestion due to Prof. Frost, namely, that the *selective* absorption of a star's atmosphere may be greater for the more refrangible rays, just as the *general* absorption of the sun's atmosphere is greater for such rays, the character of a spectrum being the resultant of radiation and absorption phenomena.

As first pointed out in connection with the meteoritic hypotheses, these stars represent a very early stage in sidereal evolution, and we note that Prof. Campbell adopts this view. He finds also that the variations of spectrum in passing from one star to another indicate that many steps in the evolutionary process are represented.

PARALLAXES OF STELLAR SYSTEMS.—The possibility of determining the parallax of a binary star, and hence the dimensions and mass of the system, by a spectroscopic observation of the relative velocity in the line of sight, was first pointed out by Fox Talbot in 1871, but the suggestion has not yet borne fruit. Some hesitation in taking up this interesting piece of work has no doubt been due to the smallness of the velocity to be measured in most cases; but now that such a high degree of accuracy is attainable, there is no longer any reason to suppose the method impracticable. A very simple way of computing the parallax from an observed velocity in the line of sight was introduced by Dr. Rambaut a few years ago, a knowledge of the orbital elements being assumed (*Monthly Notices*, vol. l. p. 302). This paper seemed to supply all that was needful in the way of facilitating the necessary computations; but Dr. See has recently treated the subject somewhat differently (*Ast. Nach.*, No. 3314). The hodograph of an ellipse being a circle, the velocity at any point in the ellipse is represented by the radius vector of the hodograph which is parallel to the tangent to the orbit at the point in question. The radius of the hodograph can be determined from the spectroscopically observed velocity, and the value of the velocity in the line of sight can then be predicted

for any instant whatever. From the orbital velocity it is easy to deduce the length of the semi-axis major of the orbit, and the parallax is equal to the semi-axis major in seconds of arc, divided by the length of the same when expressed in astronomical units. The sum of the masses follows from the ordinary application of Kepler's third law. Dr. See lays special stress upon the importance of these investigations being taken up practically, as they will furnish us with "an absolute parallax exact to the highest degree," and will also enable us to apply a rigorous test of the universality of the law of gravitation. It is known already, from micrometrical measures, that Kepler's second law holds good for binary stars, and therefore that the force is central; but it remains to be shown that the principal star is in the focus of the real ellipse.

THE SOLAR PARALLAX.—Among the various methods suggested as suitable for the determination of the solar parallax, that afforded by the parallactic inequality in the motion of the moon deservedly takes a high place. The reason is that in this particular term the parallax of the sun is multiplied by a coefficient which increases the quantity to be determined in the approximate ratio of 1 : 15, so that an error of a tenth of a second in the inequality would not produce an error of one-hundredth in the parallax sought. But in deriving the solar parallax it is necessarily assumed, that the relation between these quantities is accurately given by theory. Unfortunately there has been a discrepancy between the coefficients derived by Hansen and Delaunay, and the accepted explanation has not been the correct one. In order to ensure identity between Hansen and Delaunay it was necessary to suppose than an error existed in the highest term computed by Delaunay, and that the deviation of the remaining terms from the general character of the series did not exist. Recent work by Mr. Hill and Prof. Brown has, however, confirmed the accuracy of Delaunay's theory so far as this particular term is concerned, though it leaves a general doubt on the legitimacy of neglecting the higher terms in some of the series in other parts of the theory. Prof. Newcomb points out (*Astronom. Jour.* No. 356) that this more recent discussion of Messrs. Hill and Brown demands an increase on the theoretical value of Hansen, on which he had previously relied, of $0''\cdot30$, and consequently a diminution in the solar parallax of $0''\cdot021$ giving the corrected value of $\pi = 8''\cdot773$.

THE EPPING FOREST MUSEUM AT CHINGFORD.

THE opening of this museum, which we announced in our last week's issue as having been fixed for Saturday, November 2, was in every respect an interesting ceremony, and marks a period in the history of the Essex Field Club, of which this active society may well feel proud. Two or three years after the foundation of the Club in 1880, an informal meeting was held at the residence of Mr. E. N. Buxton, with a view to starting such a local collection, but the Conservators at that time had not long been in charge of the Forest, and they did not see their way to giving house-room for the museum in the old lodge known as "Queen Elizabeth's." The founders of the Club, however, have never lost sight of the desirability of having such a collection in the Forest district, and in February 1894, a special meeting of local residents and others was convened, and a local sub-committee formed for the purpose of forwarding the scheme. A subscription list was opened, and a sufficient sum raised to warrant another application to the Conservators for the use of Queen Elizabeth's Lodge. This was granted, and the Banqueting Room, which from time immemorial has been unoccupied and devoid of fittings, has now undergone transformation into a museum, which was declared open to the public as a part of Saturday's proceedings. The arrangement of the collections, illustrating the natural history, geology, archæology, and topography of the Forest, has been entirely carried out by Mr. William Cole, the Hon. Secretary of the Club, aided by his brothers and a few zealous workers who gave their co-operation, notably Messrs. W. Crouch, I. Chalkley Gould, A. Greenhill, and others. On Saturday afternoon a very representative gathering of scientific men took place at Chingford, to assist at the opening ceremony. The members and guests, comprising among the former Sir William Flower, Mr. Edward North Buxton, Profs. R. Meldola and G. S. Boulger, Mr. J. E. Harting, &c., and among the latter a large number of the Epping Forest Committee of the Corporation of London, were received by the President of the Club, Mr. David Howard, in a room adjoining the museum. After a few introductory remarks by the President, Sir William Flower addressed the meeting on the general subject of local museums and the advantages to be derived from their establishment. Mr. Deputy Halse, the Chairman of the Epping Forest Committee, then expressed, on behalf of the Corporation, the satisfaction which they all felt in being associated with the Essex Field Club in the movement, and declared that from Monday, the 4th, the collections would be available for public inspection. The party then proceeded to view the museum, and great satisfaction was expressed at the large amount of material which had been brought together in a comparatively short time and with very modest financial means. Mr. Greenhill's collection of flint implements from the valley of the Lea, Mr. T. Hay Wilson's set of drift rock materials from the local glacial gravels, Mr. Crouch's shells of the Dengey Hundred, the cabinets of Forest flowering plants, fungi and insects, and the interesting set of relics found during the Club's explorations of the Forest earthworks, were all much admired. A pamphlet by Mr. Chalkley Gould, being one of a proposed series of museum handbooks, was distributed at the meeting. The author in this pamphlet gives a description of the Romano-British station at Chigwell in illustration of the specimens which he has contributed to the museum. After the inspection the party assembled for tea at the Royal Forest Hotel, some eighty or ninety members and visitors being present. At a meeting of the Club, held after tea, the President moved a vote of thanks to Mr. William Cole and his coadjutors for the large amount of work which they had voluntarily done on behalf of the museum. This was warmly seconded by the Rev. A. F. Russell, the rector of Chingford, who is chairman of the local sub-committee. Mr. Cole having acknowledged the vote of thanks, Mr. A. Smith Woodward (of the British Museum) then gave a short address, in the course of which he pointed out the essential requirements that the museum should fulfil in order to be of real use, and commented most favourably upon the arrangement of the collections, their contents, and their mode of display. Sir William Flower expressed his concurrence with Mr. Woodward's remarks, and made some further observations and suggestions, especially dwelling upon the importance of taking steps to insure the permanence of the museum when those who had laboured so well for its foundation were no longer able to carry on the work. In the course of his remarks he paid a high tribute to the general work of the Essex Field Club, of which he had been an honorary member almost from the time of its foundation. Prof. Meldola, in proposing a vote of thanks to Mr. Deputy Halse, pointed out that the element of permanence to which Sir William Flower had alluded was most likely to accrue from their association with the Epping Forest Committee. This vote having been seconded by Mr. E. N. Buxton, and replied to by Mr. Halse, Mr. Harting made some remarks on the danger of encouraging promiscuous "collecting" by schoolboys, and the proceedings terminated. Favoured by an exceptionally brilliant autumnal afternoon, the meeting was a distinct success, and must have given great satisfaction to its promoters. The museum is necessarily small, but a good beginning has been made, and the time may be looked forward to when increased accommodation will be required. The feature which most strongly commends it to students of natural science, and lovers of the Forest generally, is the purely local character of the collections. No more appropriate use of Queen Elizabeth's Lodge could possibly have been made, and the Corporation of London have done wisely in allowing the Essex Field Club to found an institution which, however small and unpretentious, is, even as at present appointed, a distinct boon to all frequenters of the Epping Forest district.

CONCENTRATION OF GOLD ORES.[1]

WHEN gold mining is a new industry in any country, the methods of extraction are often somewhat rough and ready. With great quantities of rich ore waiting for treatment or easily obtainable, the mill-man is usually intent on obtaining the greatest possible quantity of bullion in a short time, rather than on establishing a good system of reduction, which in the

[1] "Report on the Loss of Gold in the Reduction of Auriferous Veinstone in Victoria." By Henry Rosales. (Issued by the Department of Mines, Melbourne, 1895.)

long run would extract the maximum percentage of gold per ton at the minimum cost. It matters little to him how much gold runs off in the tailings into the nearest stream, so long as enough is extracted to pay expenses and yield a handsome profit. When, however, the industry becomes firmly established, the aspect of affairs is changed. The richer mines can afford to spend something in endeavouring to improve their practice; the poorer ones have their very existence threatened by the loss of 30 or 40 per cent. of the gold, which has been raised from a great depth, only to be left on the dumping ground.

This stage has long been reached in the older gold fields of Australia, such as those in Victoria, where the industry has always been carefully nursed by the Government. One of the latest proofs of the solicitude of the Victorian Department of Mines is the issue of this report of Mr. Rosales, the veteran expert on concentration, who gained a Government prize for an essay on the subject as long ago as the year 1861. The report deals with the concentration of tailings from the stamp battery, and although it is specially applicable to Victoria, nevertheless it contains much information and many suggestions which deserve careful study by metallurgists in all parts of the world, and may be particularly valuable to the workers in South Africa.

In Victoria, as in many other countries, the majority of the gold ores found are "free-milling," yielding a fair percentage of their gold when amalgamated with mercury. The usual method of treatment is to crush the ore in a stamp-battery, a little mercury being added in the mortars, and to pass the pulp over amalgamated copper plates, by which most of the free gold is retained. The "battery sands," still containing a little free gold and a varying percentage of auriferous sulphides of the heavy metals, are then treated by various machines, such as canvas tables, vanners, percussion tables, blanket and wooden strakes, and revolving buddles, with a view to separate the heavy particles in which the gold is contained from the lighter worthless gangue. The concentrates are treated by grinding to impalpable pulp with mercury in iron pans, by chlorination or by smelting, according to the nature of the sulphides and to the other conditions.

The tailings from the orthodox concentrating machines would be allowed to run to waste if it were not that, on almost every mine in Victoria, they are compelled to run the gauntlet of the simple contrivances of a few Chinamen, who pay tribute to the mine-owner for the privilege of taking his leavings, and who extract enough gold to provide themselves with a living. Nevertheless it was stated in 1889, on the very high authority of the late Government analyst, Mr. J. Cosmo Newbery, that the tailings of the quartz-mining districts, even after passing the Chinese tables, contained in general from two to two and a half dwts. of gold per ton—some 15 per cent. of the amount originally contained in the ore. The gold thus lost is estimated as being of the value of over £350,000 in the year 1894, and a similar state of things is unfortunately only too prevalent in other countries.

Experts are agreed that it is the methods of concentration which are chiefly answerable for the continuance of this unsatisfactory state of things, not so much because the machines now at the disposal of the metallurgist are defective, as that in many cases they are set to do work for which they are inappropriate, although capable of dealing effectively with certain classes of material. In particular, the neglect on the part of metallurgists to classify the crushed ore according to size has been fatal to good concentration in a countless number of cases, and this mistake has not yet been generally rectified.

Let us suppose that a gold ore has been crushed so as to pass through a screen equivalent to a wire-sieve with thirty holes to the linear inch. The particles of ore are of all sizes, ranging from those which can just pass through the screen down to perfectly impalpable powder. From 20 to 50 per cent. would easily pass through a 100-mesh sieve, and a part of the ore, the "slimes," is so finely divided that it settles in still water with great difficulty. In spite of this, the whole mass, without any classification, is perhaps, after treatment with blankets, hurried over some one type of concentrator favoured by the manager, and the tailings allowed to escape without further treatment.

For example, a percussion table with "end-blow" is used, and the coarser particles of pyrites are readily separated from the remainder of the ore by its action. It usually happens, however, that the valuable sulphides, being softer than the quartz and other constituents of the gangue, are in the main more finely pulverised than the latter, so that the slimes are the richest parts of the ore, and these, under the circumstances, will almost all escape. Thus at the Johnson's Reef Mine, Eaglehurst, it was found that the "slimes," though constituting only 3 per cent. of the pulp, contained 21 per cent. of the gold, while 44 per cent. of the pulp, which was retained on a 60-mesh sieve, consisted mainly of quartz grains, and was absolutely worthless.

Or, in the alternative, the battery sands may be sent directly to some travelling belt table, such as the Frue vanner—a machine capable of doing splendid work in saving rich slimes—with the result that the coarser particles, valueless in themselves, interfere with its efficiency. Mr. Rosales cites the case of a mine at Ballarat, where the costly Frue vanners, which had been set to treat unclassified battery sands, were discarded in favour of the cheaper percussion tables, the fact being that neither concentrator could be expected to save the pyrites properly, the vanner being no more fit to treat coarse material than the percussion table is adapted to concentrate slimes. It would have been better to use the two machines successively on the same material, although even then, in the absence of classification, losses could not have been prevented.

Mr. Rosales has not been content to criticise, but has added a sketch of a complete system of concentration, which, with modifications, would be applicable to almost every gold ore likely to be met with. The keynote of the system is classification, and he can hardly be accused of laying too much stress on it, seeing that it has been neglected more generally than any other consideration in the past. He favours hydraulic classifiers (inverted pyramidal or pointed boxes of various forms) for separating the slimes from the sand; but, on the other hand, he considers that the division of the sand itself into two or three classes, according to the size of the grains, is best effected by revolving screens or trommels.

This view will undoubtedly be called in question. It is rare that a finer screen than one containing twenty holes to the linear inch is fitted to these machines, and although 60-mesh screens have been employed, the smallness of the capacity of trommels supplied with such fine sieves, and the great cost of repairs caused by their rapid wear, seem to render it unlikely that they will ever come into wide use. In revolving screens the effective surface operating at any one time is only a few inches wide, and, if they were fitted with 100-mesh sieves, it is to be feared that continuous clogging would reduce their capacity almost to the proverbial teaspoonful. There seems no adequate reason why the cheap, handy, rapidly-acting pointed boxes should be passed over, and if Mr. Rosales would press these, instead of the trommels, on Australian mill-men, he would perhaps find a more ready acceptance of his suggestions. It is true that when pointed boxes are used, the particles of ore in each class are "equivalents" (*i.e.* those falling at an equal rate in water), and not equal in size, particles of high density being left mixed with somewhat larger ones of lower density, but the classification is usually sufficient for the purpose.

For the rest, Mr. Rosales seems to lay more stress on efficiency than on cheapness. When, as in his complete system, nearly twenty different machines, without counting duplicates, are at work, each with a different purpose, in removing the auriferous sulphides from one kind of ore, the loss of gold may be reduced to little or nothing, but it is evident that the extra amount saved is not all clear gain. An additional percentage of gold may often be obtained at a loss, even by an automatic machine if it is costly to buy and to keep in repair.

No sudden drastic changes, however, are proposed by Mr. Rosales. The losses of gold in Victoria and elsewhere are undoubted, and until it has been shown that they cannot be profitably reduced, no shirking of the matter is admissible. Tests on each mine by sieving and assaying in the laboratory (which, alas! too often is non-existent) can alone show in what direction the practice may be improved, and, if proper attention were paid to the slimes only, many gold mines would have a much brighter outlook than at present.

In conclusion, a word may be said in protest against the unscientific and misleading Australian (and English) method of reporting assays of gold ores. The actual weight of gold extracted from the sample of ore is seldom recorded, and the probable error is quite undiscoverable. An observed weighing of 0·001 grain may be reported as 15 grains per ton, or may appear as two, three, or more times this amount. In every case the unit in the report is much smaller than that used for the observation. What analytical chemist would be guilty of such practices in his other work?

T. K. ROSE.

A DESTRUCTIVE PLANT PARASITE.[1]

A DISEASE of vine-leaves, characterised by the presence of brown or blackish blotches, which frequently spread over the entire surface of the leaf, has been known in European and American vine-growing districts under various provincial names for some years. This disease, known in France as *brunissure*, was investigated by Viala and Sauvageau, who concluded that it was due to the presence of a parasitic organism to which the name *Plasmodiophora vitis* was given. Prof. Debray's researches show that brunissure is far more generally distributed than was hitherto suspected, having been detected by this observer in plants belonging to forty-two natural orders. In like manner, the leaf is not the part most frequently attacked, as supposed by Viala, but root, branch, flower, and in fact every portion of a plant is liable to attack. Owing to the absence of spore-formation, zoospores, nuclei, and slender pseudopodia, coupled with the fact that, although a parasite, there is no trace of malformation of the host, Debray considers that the organism under consideration cannot be included in the Plasmodiophoræ, nor in any other recognised family, and proposes for its reception a new family, Pseudocommideæ, and a new genus, *Pseudocommis*, allied to Vampyrellæ and Myxomycetæ. The supposed organism when in plant cells is difficult to distinguish from the protoplasm of the cell, and more especially the nucleus; it is, however, more refringent, and usually remains intact after the protoplasm has been destroyed by the use of eau de Javelle. Iodine-green and methylene-blue give a green and blue stain respectively; the most certain reaction, however, is said to be chlor-iodide of zinc, which gives a yellow or brown colouration to the plasmodia. The organism is met with under various forms in the cells of the host, never occurring in the intercellular spaces; the plasmodium may be intimately mixed with, and almost indistinguishable from the protoplasm of the cell, or distinct from the cell-contents and densely vacuolate, or finally, in assuming a spherical form, perfectly homogeneous, or with a few spherical vacuoles. Under certain conditions the plasmodium travels from the interior of the cells of the leaf or other part of the plant to the surface, where it appears as a slimy or gummy secretion, and by this means passes on to other parts of the plant which are attacked. Sometimes the external plasmodium becomes hardened into wax-like masses or cysts, which are considered to represent a resting-stage. The appearance and spread of the disease is much influenced by meteorological conditions, a sudden chill favouring its development. No preventive based on experiment is given, but it is suggested that badly diseased parts should be removed, and the external migration of the parasite checked by a dusting of powdered lime.

If Debray's observations prove to be correct, we have in *Pseudocommis* the most universally diffused and destructive of plant parasites hitherto known.

[1] "La Brunissure chez les végétaux," *Revue de Viticulture*, 5 Rue Gay-Lussac.

SCIENCE IN THE MAGAZINES.

EVERY individual, as Prof. Milnes Marshall used to say, climbs up his own genealogical tree. Embryology shows how human lineaments are developed from a widely typical animal form, and evidences of the same relationship can be obtained from the study of the infant after birth. In the *Fortnightly*, Prof. Sully pleads for such study. "Ours is a scientific age," remarks he, "and science has cast its inquisitive eye on the infant. We want to know what happens in the first all-decisive two or three years of human life, by what steps exactly the wee amorphous thing takes shape and bulk, both physically and mentally. And we can now speak of the beginning of a careful and methodical investigation of child nature by men trained in scientific observation. This line of inquiry, started by physicians, as the German Sigismund, in connection with their special professional aims, has been carried on by a number of fathers and others having access to the infant, among whom it may be enough to name Darwin and Preyer." The biologist is able to use the physical development of a child to show man's kinship to the lower animal world, and the development of an infant's mind indicates to the psychologist how the mental history of the race has been evolved. It does not need a very acute observer to see the intellectual and moral resemblances between the lowest existing races of mankind and children. Several anthropologists have studied this phase of child-life, and have found it full of interest. The difficulty is to get systematic and scientific observations of children. Prof. Sully shows that the work is worth doing, and indicates some of the lines of study to be followed; all that is needed is methodical and trustworthy registration of the successive stages in the child's development.

A second article in the *Fortnightly* is a reply by Prof. Karl Pearson to an article in the September number of the *Review*, where Dr. St. George Mivart attempted to describe the limits of scientific knowledge and inquiry, and to show that many teachers of science were dogmatic, or "denominational," as he called it. Two other articles in which some of our readers may find interest are "Brahminism and the Foundations of Belief," by Vamadeo Shastri, and "Vegetarianism," by Mr. T. P. Smith.

An article on Pasteur, contributed by Profs. Patrick Geddes and J. A. Thomson to the *Contemporary*, is a readable and fairly full statement of his personal life and scientific work. The authors thus sum up Pasteur's legacy to the world: "There is the impulse which he gave, after the successful organisation of his own Institute, to the establishment in other countries of similar laboratories of preventive medicine, and, one may also say, of experimental evolution. There is his educative work at Strassburg and Lille, at the École Normale and the Sorbonne, and, above all, in the smaller yet world-wide circle of his immediate disciples. To general biology his chief contribution has been the demonstration of the part which bacteria play, not only in pathological and physiological processes, but in the wider drama of evolution. To the chemist he has given a new theory of fermentation; to the physician, many a suggestive lesson in the etiology of diseases; and a series of bold experiments in preventive and curative inoculation, of which Roux's treatment of diphtheria, and Prof. Fraser's new remedy for snake-bites, are examples at present before the public; to the surgeon, a stable foundation, as Lister acknowledged, for antiseptic treatment; to the hygienist, a multitude of practical suggestions concerning water-supply and drainage, disinfection and burial. On brewer, distiller, and wine-maker he has forced the microscope and its results; and he has shown both agriculturist and stock-breeder how some, at least, of their many more than ten plagues may be either averted or alleviated." In the same *Review* Mr. Herbert Spencer traces the development of the judge and lawyer, and points out the relations between the priestly and judicial functions. There is also a forcible and philosophical reply by Father Tyrrell to Miss Cobbe's utterances in the October number. We content ourselves with giving two of the thirteen points upon which Father Tyrrell bases his position; they are: (1) as animals vary in sensibility, our duties concerning them vary also; (2) in the abstract, vivisection is not only permissible but laudable in certain conditions. Whether these conditions are or can be realised is a matter of opinion. He concludes: "Whatever one may think of the old-fashioned psychology on which this system rests, no one can deny that it is at least coherent and in keeping with the common sense of the best part of mankind, and that it offers a full and firm basis for a humane and reasonable treatment of animals, without entailing any of those hopeless problems which Miss Cobbe has to encounter in the application of her system."

A fine portrait of the late Prof. von Helmboltz, taken on the day of his last appearance in the lecture room, by C. Riborg Mann, appears in *Scribner*, accompanied by a brief summary of his leading contributions to science. The circumstances under which the photograph was taken are thus stated by the author: "At the close of his lecture on Saturday, July 7, 1894, Prof. von Helmholtz, at my earnest request, remained a few minutes in the class room and allowed me to photograph him. He stands as he was accustomed to appear before his students, the formulas as he had just written them remaining on the blackboard as a suitable background. By a strange working of fate, that was the last day on which he lectured, excepting one, when he gave some matter supplementary to this occasion; and this is his last photograph." A paper entitled "The Logic of Mental Telegraphy," contributed by Prof. Joseph Jastrow to the same magazine, should be taken to heart by a gullible public. Nothing is said about the attempted experimental tests of thought-transference, which may be worth investigation, but it is shown that coincidences will account for the possibilities of mental telegraphy believed in by the popular mind.

A few reminiscences of Huxley's habits and work at the

Royal College of Science, South Kensington, are contributed by Prof. G. B. Howes to the October number of the College's *Magazine*, and are accompanied by an excellent portrait of Huxley. This article throws some interesting side-lights upon Huxley's great personality, especially with reference to his bearing towards his students and subordinates.

A passing allusion will suffice for the remaining articles of scientific interest in the magazines that have reached us. *Longman's* contains a popular description of the making of kelp, by Mr. D. J. Robertson, and also a paper on the disappearance of gulls from "Pallinsburn Gull Pond," by Mr. P. Anderson Graham. In *Good Words* Sir Robert Ball writes on "Halley," Sir Herbert Maxwell, Bart., pleads for the preservation of the "Fowls of the Air," and the Marquis of Ormonde describes a short cruise to Norway and Spitzbergen. The *Sunday Magazine* contains the concluding paper by "Eha," on "Voices of the Indian Night." *Chambers's Journal* has, among the subjects of its popular articles: "The Coal of the World," "Migrations of Fish," "Some Modern Uses of Glass," and "A Bundle of Paradoxes." The *Strand Magazine* has a number of graphical representations of statistics referring to the coinage productions of the Royal Mint, by Mr. J. Holt Schooling. The *National* contains a brief appreciative note on Pasteur's work. In addition to the magazines mentioned, we have received the *Quarterly Review*, *Century Magazine*, *Humanitarian* (in which occurs a paper by Prof. W. F. Barrett, on "Dynamic Thought"), and the *English Illustrated Magazine*.

THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM.[1]

SUMMARY OF THE CHIEF SCIENTIFIC RESULTS OBTAINED DURING THE YEAR 1894.

I. *England and Wales.*

THE survey of the Lower Silurian rocks of the Isle of Man has been continued by Mr. G. W. Lamplugh, who finds that the Skiddaw slates of this island, although they possess much lithological variation, are essentially the same mass throughout and are hardly likely to disclose any base to the series. Nor has it been possible to trace any sub-divisions, equivalent to those in the Lower Silurian rocks elsewhere, owing to the absence of fossils.

Reference was made in the previous Report (1893) to certain conglomerates or breccias which it was suggested may have been produced by the breaking up of sandy slates and grits under intense shear strain. These remarkable rocks have been found during the past year to attain an importance altogether unsuspected. Mr. Lamplugh has traced them in definite bands following the prevailing strike of the Skiddaw slates, and generally intercalated between an argillaceous and a more or less arenaceous group of strata. He has found one band to run continuously for eight miles, and thereafter, somewhat less clearly, for four miles further.

In the area of South Wales considerable tracts of Old Red Sandstone have been mapped during the past year by Mr. J. R. Dakyns and Mr. A. Strahan; and so far the following local subdivisions have been recognised:—

(3) Grey quartz-grits and conglomerates with some red sandstones. This group forms the uppermost of the whole series.

(2) Massive red sandstones with some conglomerates and a few red shales, as well as occasional grey sandstones and thin limestones (cornstones).

(1) Red and variegated marls with bands of soft red sandstone and thin limestones (cornstones).

These three sub-divisions pass into each other.

In Devonshire and Cornwall the re-survey of the Devonian formation and associated igneous rocks has been continued by Mr. Ussher, who has recognised that Upper Devonian strata are largely developed in the southern parts of these counties. Thus they are found skirting the Dartmoor granite, from Kingsbridge Road to Shaugh Prior, not far from Plymouth. In the Plymouth district, they consist of slates with local volcanic materials and a mass of porphyritic diabase at Ford, near Devonport. As they range into Cornwall, they present some specially interesting features. Besides retaining their evidence of contemporaneous volcanic action, they have yielded fossils which prove their stratigraphical position and allow of their being correlated with the Upper Devonian group of other regions.

The progress of mining, since first the maps of the coal-fields were published, has been so great that many of these maps have become more or less obsolete. It is therefore highly desirable, from an industrial and national point of view, that the surveys of our mineral fields should be revised, in order to place within reach of the mining community, and of the public generally, an accurate representation of the various coal-fields on which so much of the material prosperity of the country depends.

The re-survey of the great coal-field of South Wales has now been in progress for three years, and during the past year that of the North Staffordshire and Leicestershire fields has been begun.

During last summer certain improvements were made in the mapping of the Whitehaven district, particularly in regard to the boundaries between the formations and the positions of the faults. One of the most interesting points in this re-examination, made by Mr. A. Strahan, was the proof obtained of the existence of two distinct systems of faults, the one older than the Permian period and running from south-west to north-east, the other later than that period and trending from south-east to north-west. This fact had been previously insisted upon by Mr. J. D. Kendall, to whom the Survey is greatly indebted for his generous courtesy in supplying all the information which he had amassed during a residence of many years in the district as a mining engineer.

The chief work of the past year among the Cretaceous formations has been the tracing, by Mr. Jukes-Browne, of the various sub-divisions of the Chalk over tracts of the southern counties where they had not been previously mapped. Apart from its scientific interest this re-survey of the Chalk is of great economic importance. The maps will henceforth show at a glance the distribution of the various members of the Chalk, and thus will furnish accurate information for the guidance of those who have to sink wells or deal with the water-supply and drainage of the wide chalk-districts of the south of England.

Mr. Whitaker and Mr. Reid have continued the revision of the Tertiary strata in the Hampshire Basin.

During the past year the survey of the Superficial Deposits for the construction of an agronomic map of the country has made good progress in the midland and southern counties, and much new information has been obtained with regard to the extent of the drifts in Monmouthshire and South Wales.

In the valleys that intersect the South Wales coal-field, and chiefly end in the broad dip-slopes of the northern outcrop of Millstone Grit, much boulder-clay as well as gravel has been noticed by Mr. Gibson. It is almost entirely of local origin. That these uplands were overspread with ice is shown by the occurrence of glacial striæ on the Millstone Grit at a height of about 1500 feet above the sea. Further proof that the ice must have existed in considerable mass has been obtained in the excavations of some new waterworks at Nant-y-bwch, where a hill of sandstone upwards of 200 yards in length has been found to be a transported mass. Though its bedding is only slightly disturbed, yet the whole mass has been ascertained to lie upon boulder-clay, and must therefore be regarded as a huge boulder.

In the Isle of Man, Mr. Lamplugh has observed that the marked distinction referred to in the previous Report, between the insular drift of the hills and the extra-insular drift of the low ground still continues. The relative distribution of these drifts seems to prove that both are of truly glacial origin. Most of the deeper glens in the Isle of Man were probably filled with local glaciers before the coming of the great south-flowing ice-sheet which afterwards overrode the island up to its highest summits. As shown by numerous striæ observed on the Skiddaw slates, the general march of the ice during the height of the glaciation seems to have been from some point west of north, instead of east of north, as usually stated. A bed of fine warp or silt in the glacial series of Kirk Michael may prove to be of some economic value. It has been locally used in past time as a fuller's earth, and an effort is now about to be made to introduce it to a wider market for the same purpose.

II. *Scotland.*

As announced in the previous Report, all the tracts of Lewisian gneiss on the mainland, from Cape Wrath to the Kyles of Skye, have been mapped, but there are many displaced tracts or slices of that formation which lie to the east of the great line of com-

[1] Extracted from "Annual Report of the Geological Survey by Sir Archibald Geikie, D.Sc., LL.D., F.R.S., Director General," published in the *Report of the Science and Art Department* for the year 1894.

plication, and have undergone more or less deformation in the course of the gigantic earth-movements which placed them in their present positions. So far as at present known, no unmoved tracts of the oldest gneiss are to be looked for in the regions of Ross-shire and Inverness-shire yet to be mapped, but there may be many more or less recognisable disrupted masses among the crystalline schists of that region.

The only area where any of the Lewisian gneiss was mapped last year, on the western or undisturbed side of the great line of displacement, lay in the Island Raasay, where Mr. Teall completed the survey of these oldest rocks. As far as the mapping of the north-west Highlands has advanced, the various crystalline rocks older than the Torridon sandstone, and comprised under the general designation of Lewisian gneiss, may be divided into five distinct groups. (1) What has been termed the "fundamental complex," consisting of various more or less banded and foliated rocks which form together the oldest, and chief part of the gneiss. (2) Highly basic dykes cutting the fundamental complex. (3) Dykes and sills of dolerite, epidiorite, and hornblende-schist. (4) A few dykes of peculiar composition. (5) Gneissose granite, and pegmatite.

Mr. Teall has devoted himself, both in the field and with the microscope in the office, to the patient study of these rocks, and he has at last been able to formulate his views regarding the nature and composition of the various rocks comprised within the first of these sub-divisions, the "fundamental complex." He reports to me that over the greater portion of the area between Skye and Cape Wrath the rocks of the "fundamental complex" have decided affinities, both as regards chemical and mineralogical composition with plutonic igneous products, and his detailed Report, so far as these rocks are concerned, is now fairly complete. They are essentially composed of olivine, hypersthene, augite (including diallage), hornblende, biotite, plagioclase, orthoclase, microcline, and quartz; and the laws of paragenesis are the same as those which govern the composition of peridotites, gabbros, diorites, and granites. It is rare to find any one petrographical type persistent over a large area. Variations in the relative proportions of the different constituents are almost everywhere recognisable, and these variations may be either abrupt or gradual. One general law appears to have been established as far as the fundamental complex is concerned. Whenever the relative ages of two distinct petrographical types can be clearly ascertained, the more basic is older than the more acid.

In classifying the rocks, either with reference to structure or composition, difficulties arise in consequence of transitions in various directions. Many schemes have been proposed; and the following one, based primarily on mineralogical composition, and to a subordinate extent on structure, has been devised by Mr. Teall for descriptive purposes. Theoretical considerations have been excluded, and it is hoped that whatever view may be finally adopted, the broad general facts will be found to have been correctly recorded:—

I. Rocks composed of ferro-magnesian minerals without felspar or quartz.

(1) Pyroxenites.
Locality. Scourie, Drumbeg.
(2) Hornblendites.
Same localities as pyroxenites, and also as lumps in the gneiss of many other localities.

II. Rocks in which pyroxenes are the dominating ferro-magnesian constituents. Felspar always present, and in some cases quartz.

(*A*) Without quartz.
(*a*) Hypersthene-augite-rocks.
(1) With garnet (pyroxene-granulites).
Locality. Scourie.
(2) Without garnet (rocks of the Baltimore-Gabbro type).
Locality. Scourie, Gruinard.
(*b*) Augite-rocks. Gabbros in structure and composition, but forming part of the fundamental complex, and often associated with quartz-bearing rocks of a similar character.
Locality. Kyle Sku, Loch Inver.
(*B*) With quartz.
(1) Augite gneiss.
Locality. Kyle Sku, Loch Inver.

III. Rocks in which hornblende is the dominating ferro-magnesian constituent.

(*A*) Without quartz, or containing it only in small quantity. Rocks basic in composition.
(*a*) Rocks massive or only slightly foliated (Amphibolites).
(1) Epidote-amphibolite.
Locality. Near Stoer.
(2) Zoisite-amphibolite.
Locality. Sangomore Bay.
(3) Garnet-amphibolite.
Locality. Between Scourie and Laxford Bridge.
(*b*) Rocks foliated:—
Hornblende schist.
Locality. Between Laxford Bridge and Durness, also at Shieldag, Rona, and many other localities.
Note.—Many of the hornblende-schists found in the Lewisian gneiss are foliated dykes.

(*B*) With quartz. Rocks intermediate or acid in composition.
(1) Rocks with compact hornblende and a granular structure. Hornblende-gneiss (proper).
Locality. Between Laxford Bridge and Durness, Poolewe, Rona, Raasay, and many other localities.
(2) Rocks with hornblende occurring in fibrous or other aggregates:—
Locality. Between Scourie and Loch Inver, especially found in the same area as the augite-gneisses.
(3) Rocks with compact hornblende, and a more or less granulitic structure. Granulitic hornblende-gneiss.
Locality. In zones of secondary shear about Loch Inver.

IV. Rocks in which biotite is the dominating ferro-magnesian constituent. Felspar and quartz both present.

(1) Biotite occurring as independent plates or in aggregates of two or three large individuals. Biotite-gneiss (proper).
Locality. Between Laxford Bridge and Durness, Rona, Raasay, and many other localities.
(2) Biotite occurring in aggregates of numerous small individuals.
Locality. Associated with the augite-gneisses. A rare type.
(3) Biotite occurring as independent plates. Structure granulitic.
Locality. In zones of secondary shear.

While mapping the Lewisian gneiss of Raasay, Mr. Teall observed some curious patches of breccia in that island. One of these descends vertically into the Torridon sandstone, another occupies a similar position in the gneiss. The breccia consists of fragments of Torridon sandstone cemented with calcite, from which small rhombs of clear Iceland spar may be obtained. In one instance where the outlines of the breccia can be more distinctly traced, the ground plan of the mass is nearly semicircular, as if the breccia formed a plug in the Torridon sandstone.

Some interesting additions have recently been made to our knowledge of the Cambrian rocks of the north-west. Mr. Horne has found a band of fossiliferous ironstone, about two feet thick, in the "Fucoid beds" above Auchnashellach Station. The seam is full of a small discinoid or linguloid brachiopod. Mr. Macconochie has renewed his search for fossils in the *Olenellus*-zone, and has obtained additional specimens not only from the localities above Loch Maree and near Dundonnel, but from other outcrops of the same zone further to the north. He has detected fragments of trilobites together with other fossils of the same horizon on both sides of Loch Broom near Ullapool. He has likewise found them where the "Fucoid beds" appear in the River Achull, the Allatryne Burn, Strath Kaniard, Drumrunie and Knockan. Still further north Mr. Peach has obtained fragments of *Olenellus* from the same horizon at Inchnadamph. The ironstone-bed with brachiopods just referred to has been recognised by Mr. Macconochie in Glen Logan and other parts of

the Loch Maree district. It is thus shown that the "Fucoid beds" contain the fossils of the *Olenellus*-zone from the River Carron in Ross-shire to Loch Assynt in Sutherland.

An important addition to the evidence that tends to connect the quartzites and their associated strata of the south-western Highlands with those of Sutherland and Ross, has been obtained in the island of Islay. Reference was made in the last Report to the occurrence of worm-tracks in the dolomitic shales of that district which so greatly resemble the characteristic "Fucoid beds" of the north-west Highlands. Twenty specimens of tracks and burrows from the Islay shales have been obtained by Mr. Macconochie, and perhaps it is not too much to hope that eventually some of the other more distinctive fossils of the *Olenellus*-zone may yet be detected there.

In further prosecution of his mapping of the ground between Loch Carron and Loch Alsh, Mr. Peach has obtained additional confirmatory evidence of the view expressed in the last Report that the "Moine-schists" of that region are mainly altered Torridon sandstone and shale. These strata and their floor of Lewisian gneiss, which is occasionally brought up along sharp folds to the surface, are increasingly metamorphosed as they pass to the eastward.

Not less suggestive is the evidence recently obtained by Mr. Horne during his survey of the mountainous ground between the head of Loch Carron and Loch Maree. To the east of the great line of dislocation known as the Glen Logan or Kishorn thrust-plane, as in the ground south of Loch Carron, lenticles of Lewisian gneiss, brought up on the axes of isoclinal folds, occur among the Torridonian rocks, the whole series dipping in an easterly direction. That these long narrow exposures of gneiss are part of the actual floor on which the sedimentary formations rest, is proved by the occurrence of the basal Torridonian epidotic grits resting upon them. By means of this readily recognisable zone of grits and the shaly group that overlies them, it is not difficult to map out each separate isocline and to follow both the succession of the rocks and the structure of the ground.

As we advance eastwards, this metamorphism becomes more marked, the peculiar type or structure of the Moine or eastern schists coming out more and more clearly. It is difficult to understand that any other explanation of the sections can be adopted than that which obviously presents itself on the ground, namely that rocks having every character of true Moine schists, have here been produced by the alteration of a portion of the lowest Torridonian grits and shales with infolded cores of Lewisian gneiss.

Mr. Hinxman, working in that part of Strathspey which embraces the districts of Rothiemurchus, Abernethy and the ground between the Spey and the Dulnan, west from Aviemore, has met with a large tract of biotite-granite, similar to that of the Cairn-Gorm range, to which he proposes to give the name of Monadhliath granite, since it forms the eastern border of the Monadhliath mountains. He has ascertained that in this area, though the granite is fringed with abundant apophyses which penetrate the gneiss to distances varying from a few feet to 300 yards, no fine-grained edges indicative of the chilling of the intruded granite are to be seen. The injections of eruptive material have usually taken place along the planes of foliation, and the bands or planes of granite tend to branch out into mere strings. Besides the apophyses that can actually be traced into the main body of granite, many sills, bands or lenticular veins of similar material, may be seen in the gneiss immediately around the granite, and doubtless emanating from it. All the granitic bands, sills or veins, whether visibly proceeding from the granite mass or not, are thoroughly granitoid in texture and sometimes markedly pegmatitic. Not only do they present no chilled margins, but their crystals may be seen to interlock with those of the surrounding schists. Hence in this area there appears to be no reason to doubt that the present crystalline condition of the schists is coeval with the crystallisation of the material of the granite veins. The evidence, so far as it has at present been collected, appears to point to two conclusions. First, that the granites of Cairn-Gorm, Monadhliath, and other parts of Strathspey, together with most, if not all, of the sills and veins of granite and pegmatite in that region, belong to the same granitic protrusion and are derived from the same magma. Second, that this granitic magma has been protruded into a series of holocrystalline schists and quartzites, and that the contact metamorphism thereby superinduced, gave rise to the highly granulitic biotite-gneiss with bands of quartzite, which now forms the prevalent rock of the whole region.

In Deeside, Mr. Barrow has ascertained that the great granitic mass south of Banchory presents a very different character. The granite becomes rapidly finer in grain towards its margin, where it assumes the compact texture characteristic of a granite injected among already cooled rocks, while its apophyses are finer in grain than the main body of the rock. Of older date than this eruption is the granitic material, composed of microcline, quartz, and brown mica, which, in a vast number of narrow dykes or veins traverses the highly crystalline schists of the south side of the Dee.

The age of the red sandstones which extend along the eastern shore of Arran from Corrie to Brodick and thence across the southern half of the island, underneath the various sheets of eruptive rocks, has been much discussed. By Sedgwick and Murchison these strata were classed as New Red Sandstone, a view that was subsequently adopted also by Ramsay. Afterwards, however, Bryce and other writers placed them in the Carboniferous system, and correlated them with the red sandstones of the north of Ayrshire and Renfrewshire. A re-examination of the ground was made last spring by the Director General in company with Mr. Peach and Mr. Gunn. They found that pebbles of the Carboniferous limestone with its characteristic fossils actually occur in the breccias at the base of these red sandstones between Corrie and the north end of Arran, as was first observed some years ago by Mr. James Thomson. Closer inspection of the coast-sections and of the interior showed that, besides this evidence of a decided stratigraphical break, the red sandstone, conglomerates and breccias lie unconformably on the Carboniferous formations, though at the actual junctions the two series seem almost conformable. That they are probably Permian may be inferred on two grounds. In the first place, the lower group of false-bedded brick-red sandstones presents the closest resemblance to the red sandstones which, within sight on the opposite mainland of Ayrshire, rest upon the Coal-measures, and have been referred to the Permian period. In like manner, they resemble the red sandstones of the south of Ayrshire, Wigtonshire, and Dumfries-shire, which are also assigned to the same period. In the second place, the Arran red sandstones have been found by Mr. Gunn to enclose a contemporaneous volcanic group, a feature which is specially characteristic of the Permian series of the centre of Ayrshire, and of Nithsdale. The occurrence of *Stigmaria* in the volcanic series which lies some hundreds of feet above the base of the red sandstones seems to remove these strata from the New Red Sandstone or Trias, while the strong lithological resemblance which, both as regards their sedimentary and volcanic components, they present to the Permian series of the mainland opposite, renders it highly probable that they are Permian.

Mr. Woodward has mapped separately in Skye, as he did in Raasay, the passage-beds between the Upper Lias and the Inferior Oolite, which include shaly layers, and bands and concretionary masses of calcareous sandstone. These strata in Raasay yielded *Ammonites variabilis;* while in Skye they have afforded a form identified by Messrs. Sharman and Newton as *Ammonites Siemensi*, indicative of the zone of *A. jurensis. A. Murchisonæ* occurs in the lower part of the Inferior Oolite, and many examples of *A. humphriesianus*, and other fossils, not yet determined, have been obtained from the fine cliffs between Bearreraig Bay and Invertote. The upper portion of the Inferior Oolite does not appear to be fossiliferous on this Skye coast. It contains some shaly, and lignitic bands, and concretionary masses of sandstone, differing to some extent from the mass of white sandstones so prominent on this platform in the eastern cliffs of Raasay.

The Tertiary dykes of Skye are now being mapped, both on the north-east and south-east coasts. In the latter area Mr. Clough finds them to vary petrographically between the two extremes of pitchstone on the one side and troctolite on the other. Those of acid or intermediate character on the coast north of Loch-na-Daal often indicate the direction of flow of the molten rock in the fissure, by the elongation of the amygdales and the orientation of the rows of spherulites. From the variation in the positions of these structural lines, it is clear that the movement of the lava was by no means always vertical, but was often approximately horizontal or oscillating between the two directions. Records of the variations observed are being kept by Mr. Clough.

III. *Ireland.*

In pursuance of the work described in the last two Reports, Messrs. Kilroe and McHenry have during the past year advanced over a large tract of the difficult ground between Clew Bay and a line drawn from Clifden to Oughterard. Evidence obtained by Mr. Kilroe leads to the conclusion that the Croagh Patrick quartzite and its equivalent further south does not belong to the "Dalradian" series, but is a part of the Llandovery formation. It will thus be necessary to colour as ordinary Silurian a considerable tract of ground which has hitherto been regarded as composed of metamorphosed rocks. The rocks have undergone a certain amount of metamorphism, but never enough to destroy the clear evidence of their original clastic character.

The investigation by Mr. McHenry of the tract of ground between Clifden and Oughterard has resulted in the collection of a body of evidence which seems to disprove the existence of any Archæan rocks, at least within the area examined. What have been supposed to be rocks of that early age are believed by Mr. McHenry to consist of a complex series of intrusive masses which have pierced the schists, limestones and quartzites of southern Connemara. His survey during last year in that region has convinced him that the whole of these rocks, igneous and sedimentary, are the equivalents in age and petrographical character of the eruptive and metamorphic (Dalradian) rocks of Mayo, Sligo, Leitrim, Donegal, and other parts of Ireland.

Early in March the Director General took the opportunity to make with Mr. Peach and Mr. McHenry an examination of some of the ground around Pomeroy in Tyrone, where there seemed reason to believe that evidence might be found of the occurrence of a marginal strip of Lower Silurian rocks like those which have now been found to flank the southern border of the Scottish Highlands. On a former occasion he had observed among these rocks a remarkable group of basic lavas and tuffs, but could see no evidence to warrant their separation from the chloritic schists to the north of them. Recent mapping along the borders of the Scottish Highlands, however, having shown that a similar group of rocks in that region could be recognised as probably of Lower Silurian age, it seemed desirable that the Tyrone district should be re-examined. The result has been so far highly satisfactory. In company with Mr. Peach, who has also visited the Scottish localities, the Director General spent some days in traversing the Tyrone sections, and had no difficulty in recognising the close similarity of the rocks there exposed to those along the Highland border. The igneous rocks form a strip of country about twenty-four miles long with a maximum of nine miles in breadth, lying between the Silurian and Old Red Sandstone rocks on the south, and the crystalline schists on the north. They include diabase and porphyrite lavas, tuffs, and intrusive sheets. The lavas are interleaved with cherts and jaspers exactly like those associated with the igneous rocks at the edge of the Highlands. Apparently overlying the volcanic masses come dark shales, which might yield graptolites, likewise pale grits and occasional thin limestones. In Scotland the cherts enclose *Radiolaria*, and though these organisms were not detected in any of the Tyrone sections on the occasion of this visit, it may be confidently anticipated that they will be found on further and more detailed search. The radiolarian cherts of the Highland border, with their lavas and tuffs, appear to be a prolongation of those which with the same characters lie in the Arenig formation of southern Scotland, where they extend over a wide area. The importance of the discovery of a zone of Arenig rocks along the edge of the schists in the Highlands and in the north of Ireland will be obvious to all those who have followed the discussion regarding the structure and age of these crystalline schists.

While engaged in the preparation of the "Handbook of the Survey Collections," Mr. Watts had occasion to make many critical examinations of the rocks in the cases of the Museum. Among the new facts which this investigation has established, the following may be noticed:—The wide extent of lamprophyres in the north of Ireland; the occurrence of perlitic cracks in the quartz of the Tardree rhyolite; the remarkable replacement of olivine by tremolite, which eventually develops into idiomorphic crystals in the picrite of Glendalough; the intergrowth of biotite and hornblende in the Crossdoney granite, and the contact metamorphism around that rock.

Among the pebbles in the Drift of the east of Ireland, pieces of a granophyre, with the mineral riebeckite, are not infrequent. Prof. Sollas has been fortunate in finding for the first time one of these pebbles which contains true crystals of the mineral. He has found them to possess well-developed faces, and has been able to measure and describe them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. W. B. Prowse, of Pembroke College, has been elected to the Burdett-Coutts Scholarship in Geology, and Mr. R. M. Brydone, of New College, was awarded the scholarship which was not given last year, tenable for one year only. The Burdett-Coutts Scholarship is of the annual value of £115, and is tenable for two years.

CAMBRIDGE.—On November 4 the two vacant fellowships at St. John's College were filled up by the election of Mr. F. F. Blackman and Mr. S. S. Hough, late scholars of the College. Mr. Blackman is Demonstrator of Botany in the University, and took a first class in both parts of the Natural Sciences Tripos. Mr. Hough is Isaac Newton Student in Astronomy, and was Third Wrangler and Smith's Prizeman. Both of the newly-elected Fellows have communicated important memoirs to the Royal Society. Mr. Blackman's researches on the respiration of plants were referred to with high commendation by Mr. Thiselton-Dyer in his presidential address to the Botanical Section of the British Association.

The choice of the electors to the Professorship of Botany, vacant by the death of Prof. Babington, fell upon Dr. Marshall Ward, F.R.S., late Fellow of Christ's College, Professor of Botany at the Royal Engineering College, Cooper's Hill. Prof. Marshall Ward graduated B.A. in 1879, taking a first class in the Natural Sciences Tripos.

The State Medicine Syndicate report that, in view of the increasing importance of the study of bacteriology in relation to public health, they have decided to extend the time given to the subject in the Sanitary Science Examination, and to appoint a fifth Examiner specially conversant with it. Thirty-one candidates received the Diploma in Public Health in the last academic year.

The skeleton of a Chillingham bull has been presented to the Museum of Zoology by the Earl of Tankerville.

THE Report of the Royal Commission on Secondary Education has at last been published. The Commission was appointed in March 1894, "to consider what are the best methods of establishing a well-organised system of Secondary Education in England, taking into account existing deficiencies, and having regard to such local sources of revenue from endowment or otherwise as are available or may be made available for this purpose, and to make recommendations accordingly." The Report is divided into four parts, referring respectively to (1) previous legislation on the subject; (2) the state of things now actually existing; (3) the evidence submitted to the Commissioners, with a discussion of the views and suggestions of certain leading witnesses; (4) recommendations calculated to bring about that correlation of existing agencies and economical application of existing funds, which are required for the proper organisation of Secondary Education. Technical Education is included in the term Secondary, and the suggestions in the Report refer to both alike.

DR. FRANZ KÖNIG, Professor of Surgery in Göttingen University, has been elected successor to the late Prof. von Bardeleben in the Chair of Surgery at Berlin. Dr. Joseph Disse, of Halle, has been appointed Professor of Anatomy at Marburg. Mr. Frank H. Constant goes to Minnesota University as Assistant-Professor of Structural Engineering, and Mr. H. Wade Hibbard as Assistant-Professor of Machine Design. Dr. Partheil, of Marburg, has been appointed Professor of Pharmaceutical Chemistry at Bonn.

A FREE library, comprising museum, art galleries, and four branch libraries, has just been opened at Pittsburg. The erection of the institution has taken three years, and the cost—£200,000—has been defrayed by Mr. Andrew Carnegie.

MR. CECIL SMITH has gone to Athens to take up the Directorship of the British School there.

SCIENTIFIC SERIALS.

American Journal of Science, October.—Recent progress in optics, by W. Le Conte Stevens. This paper was read before the American Association, and gives an admirable summary of Michelson's work with the interferential comparer, of Wiener's experiments with stationary light waves, of recent researches on luminescence, and other subjects.—The quantitative determination of perchlorates, by D. A. Kreider. The method is essentially the collection of the oxygen of the perchlorate; its subsequent passage into an atmosphere of nitric oxide over a strong solution of hydriodic acid, and the titration of the iodine thus liberated with decinormal arsenic in alkaline solution. The apparatus employed consisted of a piece of combustion tubing, 10 or 12 cm. in length, drawn out at one end and connected with a receiver filled with caustic potash. A platinum boat carried the perchlorate, which was covered with a mixture of sodium and potassium carbonates. The tube was then filled with carbonic acid, and then the oxygen was evolved by fusion. The oxygen was swept by a current of CO_2 into a receiver consisting of two levelling bottles. For the action of the oxygen on hydriodic acid through the medium of nitric oxide, a bulb pipette was used with stopcocks at both ends. This was filled with a known amount of hydriodic acid, and the air expelled by CO_2, after which it was exhausted and a small quantity of nitric oxide was admitted. Then the oxygen was allowed to enter slowly under the diminished pressure, while the bulb was constantly shaken. It was then removed for titration.—Demonstration of caustics, by R. W. Wood. A strip of thin polished steel is bent into an arc formed by pins stuck on a board. A piece of cardboard is placed across the opening of the arc, and slits are cut in it about half an inch apart. A piece of photographic sensitive paper is stuck on a board inside the arc. On directing the apparatus towards the sun, parallel rays are traced from the slits to the mirror, and also their reflections, and the latter form the caustic surface appropriate to the curvature of the mirror.—The law of electromagnetic flux, by M. I. Pupin. The author endeavours to show the exact position which this law occupies in Maxwell's electromagnetic theory; to point out its limitations; to show that Maxwell's electromagnetic theory of light demands a more general form of this law; and to present a general form of this law of which the forms given up to the present are special cases.

American Meteorological Journal, October.—Fog signals and meteorology, by Prof. H. Hazen. The author discusses the penetrating power of various signals, the conditions under which fog is formed, and the effects of the winds and topography upon the audibility of the signals. He considers that, apart from the facts that a sound can be heard about twice as far with the wind as against it, and can be heard farther from an elevation than at the level of the sea, there is hardly a point which is well established. Also that the evidence points very strongly against the use of sirens or trumpets in any but a few exceptional cases where a very long range is demanded. A perplexing difficulty, referred to by the late Prof. Henry, arises from the fact that the signal often seems to be surrounded by a belt, varying in width from one to one and a half miles, from which the sound appears to be entirely absent. He considers that there is urgent need for a series of experiments from a rock or very low island, with open water for ten miles on all sides. Such experiments would probably elucidate many of the perplexing phenomena which now exist.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 16.—Prof. Meldola, F.R.S., President, in the chair.—The President announced the deaths of Prof. C. C. Babington, F.R.S., the last but one of the original members of the Society, and Prof. C. V. Riley, one of the ten Honorary Fellows of the Society, and commented upon their scientific work. Mr. W. F. H. Blandford spoke at some length on the valuable services rendered by the late Prof. Riley to the cause of economic entomology, and referred to the enormous number of papers and memoirs on the subject which he had contributed. Lord Walsingham, F.R.S., also spoke as to the importance of the late Prof. Riley's work and the respect and regard which he felt for his estimable personal qualities.—Mr. F. C. Adams exhibited a series of nineteen *Merodon equestris*, containing several varieties, showing their resemblance to wild bees of the family Apidæ, and made a few remarks on mimicry. He also exhibited specimens of *Leptomorphus walkeri*, Curt., taken in the New Forest in September last, and *Melanostoma hyalinatum*, Fln. (male and female), also taken in the New Forest in the latter part of August last. Mr. Verrall, Dr. Sharp, F.R.S., and Colonel Yerbury made some remarks on the species and their distribution.—Mr Enock exhibited, and made remarks on, specimens of the mature male and female, and the nest of *Atypus piceus*, the British Trap-door spider; also male and female specimens of *Andrena atriceps* and males of *A. fulva*.—Mr. Tutt exhibited a long series of 143 males and 25 females of *Erebia nerine*, captured in the Tyrol, partly in the Mendel Pass and partly in the Val d'Ampezza, and read notes on the species, in which he criticised the description of it, and the published observations as to its habits, by Dr. Lang, Mr. Elwes, and others. Mr. Elwes made some remarks in reply.—Lord Walsingham exhibited the type of *Pseudodoxia limulus* (Kghfr.), together with the larval cases and a preserved larva. He directed attention to the curious truncate concave head of the larva which forms an operculum to the tube, and remarked that the cases of this insect, which were apparently not uncommon in Ceylon, the larva feeding on mosses and lichens, had been known for some considerable time. So long ago as 1864, Mr. McLachlan found them in the British Museum collection of cases of caddis worms, and at that time, being only acquainted with the case, he was disposed to consider them the work of one of the *Leptoceridæ*. In 1889, Herr Rogenhofer gave the name *Fumea* (?) *limulus* to the case and its contents, and Mr. McLachlan agreed from the evidence then adduced that the insect was *Lepidopterous* rather than *Trichopterous*.—Mr. C. J. Gahan exhibited, for Mr. Turner, an imago and some larval forms of *Ledra aurita*, Linn.—Mr. G. C. Griffiths exhibited, and read notes on, hybrids between *Platysamia cecropia* (male) and *P. gloveri* (female), and between *P. cecropia* (male) and *P. ceanotha* (female); also between *Actias luna* (male) and *A. selene* (female). He stated that these hybrids were bred by Miss Emily L. Morton, of New Windsor, New York, in 1891, 1892 and 1893.—Lord Walsingham stated that at the last meeting of the Society some discussion ensued, after the reading of his paper, in consequence of his having alleged that *Grapholitha*, W., was preoccupied by *Grapholitha*, Hb. (Verz. Schm.), and he read a supplementary note on the subject explaining the references in his paper.—Dr. A. G. Butler communicated a paper, entitled "Notes on seasonal dimorphism in certain African butterflies."

PARIS.

Academy of Sciences, October 28.—M. Marey in the chair.—The Associates and Correspondents of the Academy are invited to send their photographic portraits to the Secrétariat to form part of a projected album.—Lord Kelvin read an address from the Royal Society of London, and then expressed his appreciation of the honour conferred upon him by his election as a Foreign Associate of the Academy. In his speech he referred to France as his *Alma mater* in science, and mentioned his personal connection with Regnault in 1854 at the Collège de France.—On the multiple roots of algebraical equations, by M. Brioschi.—On the differences of longitude between Nice, Ajaccio, and Rousse Island, by MM. Hatt, Driencourt, and Perrotin. A telegraphic determination in which observations have been carried out between different pairs of observers, and checked by comparing the longitude of Ile Rousse determined from Nice with the longitude of the same place determined from Ajaccio, which itself had its longitude compared directly with that of Nice. The direct determination of the difference in longitude of Ile Rousse and Nice gave 6m. 34·45s. ± 0·01s. Indirect determinations gave 6m. 34·442s. ± 0·019s., and 6m. 34·465s. ± 0·017s.—M. Armand Gautier presented the second volume of the second edition of his "Cours de Chimie," and described the points in which it differed from the first edition.—General A. de Tillo presented and described a relief map of the western part of Russia, and the bordering parts of contiguous States.—On chemical equivalents, by M. Marqfoy. The author enunciates the following as a law of chemistry, and supports it by tables printed in the abstract: "The actual equivalents of chemistry are the prime numbers comprised in the natural series of whole numbers from 1 to 300." He adds that he has established the constitutive theory of substances based on the unity of matter. He introduces *porosity* into the consideration of volumes, and asserts that he thus overthrows Dulong and Petit's law, and Avogadro's hypothesis. The author has found the following

law to hold: "The specific heat multiplied by the density equals the porosity, the porosity of hydrogen at the given temperature and pressure being taken as unity."—Observations of the comet 1895, August 20, and of Wolf's planet (1895, October 13) made at Toulouse observatory with the great telescope, and the 0·25 m. equatorial, by M. Rossard.—On the double diurnal oscillation of relative humidity, by M. Alfred Angot. It is shown that the phenomena described by M. Éginitis in a recent number of the *Comptes rendus*, is due to sea-breezes, and has been noticed previously. It does not occur in continental stations, on plains or plateaux.—Observation of an electric phenomenon, by M. Mettetal. A description of an electric fire-ball observed in stormy weather, but in the absence of thunder and lightning, at Grenoble, on October 2. The phenomenon vanished without detonation.—Researches on lithium, magnesium, and cuprous cyanides, by M. Raoul Varet. A thermochemical paper giving the heats of formation of these cyanides. It is pointed out that there is not the same parallelism between the cuprous and cupric cyanides as obtains with the mercurous and mercuric salts.—On beryllium carbide, by M. Louis Henry. The author calls attention to the weakness of M. Lebeau's argument for assigning the atomic weight 14 to beryllium, and recapitulates the considerations which have determined the acceptance of 9 as its atomic weight by most chemists.—On the analysis of emerald, by M. P. Lebeau.—On the estimation of argon, by M. Th. Schlœsing, jun. The author discusses the errors inherent in the method lately described by him, and gives results of the estimation of argon in air taken at different times and from different places. The amount found is constant at 0·934 per cent. Gases from soil show some variations in the amount of contained argon, possibly due to the solubility of this gas.—Synthetical formation of a new ketonic acid, by M. E. Burker.—On the muscles of ants, wasps, and bees, by M. Charles Janet.—On the development of nerve terminations (neuromuscular junctions and motor plates) in striated muscular fibres, by MM. G. Weiss and A. Dutil.—Liquefaction of gelatine, saline digestion of gelatine, by MM. A. Dastre and N. Floresco.—Researches on the biological value of inflammatory leucocytosis, by M. Wladimir Woronine. Localised inflammatory leucocytosis is peculiar to vertebrates, and is an accidental consequence of the particular conditions occurring in their system of blood circulation. Leucocytosis is not a purposed defence against an enemy which has penetrated the organism, as the phagocyte theory maintains. The modifications which are common to all the cases studied are not aggressive, but passive.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, NOVEMBER 7.

LINNEAN SOCIETY, at 8.—On Mimicry in Butterflies of the Genus Hypolimnas, Hübn.: Colonel Swinhoe.—A Revision of the Genus Pentas, Benth.: G. F. Scott Elliot.—An Account of the Butterflies of the Genus Charaxes, Ochs.: Dr. A. G. Butler.

CHEMICAL SOCIETY, at 8.—The Temperatures of Flames and the Acetylene Theory of Luminosity: Prof. Smithells.—The Action of Acidic Oxides on Salts of Hydroxy-acids: Prof. G. G. Henderson and D. Prentice.—Sodium Nitrosulphate and the Constitution of Nitrosulphates: Profs. Divers and Haga.—And other Papers.

FRIDAY, NOVEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—The Magnetic Field of any Cylindrical Coil or Plane Circuit: W. H. Everett.—The Latent Heat of Volatilisation of Benzene: Mr. Griffiths and Miss Marshall.—The Comparison of Latent Heats of Volatilisation: Prof. Ramsay and Miss Marshall.

SUNDAY, NOVEMBER 10.

SUNDAY LECTURE SOCIETY, at 4.—What Man can obtain from the Land: Prince Kropotkin.

MONDAY, NOVEMBER 11.

ROYAL GEOGRAPHICAL SOCIETY, at 8.—Progress of the Jackson-Harmsworth Arctic Expedition: A. Montefiore.

TUESDAY, NOVEMBER 12.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Colour-Correct Photography and a New Plate: James Cadett.—Note on the Sensitiveness of Picrated Gelatine to Light: W. K. Burton.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Customs and Habits of the Natives inhabiting the Bondee Country: Rev. Godfrey Dale.

ROYAL VICTORIA HALL, at 8.30.—Mountaineering in Central Africa: Dr. J. W. Gregory.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by Sir Benjamin Baker, K.C.M.G., President, and Presentation of Medals, &c.

THURSDAY, NOVEMBER 14.

MATHEMATICAL SOCIETY, at 8.—On the Stability and Instability of certain Fluid Motions, iii.; and on the Propagation of Waves upon the Plane Surface separating Two Portions of Fluid of different Vorticities: Lord Rayleigh, Sec.R.S.—Note on Matrices: J. Brill.—Determination of the Volumes of certain Species of Tetrahedra without employment of the Method of Limits: Prof. Hill, F.R.S.—Some Algebraical Theorems connected with the Theory of Partitions: Prof. Forsyth, F.R.S.—Certain General Series: F. H. Jackson.—An Extension of Sylvester's Constructive Theory of Partitions: Major MacMahon, F.R.S.—Note on the Representation of a Conic by a Linear Equation: J. Griffiths.—On the Representation of a Number as a Sum of Squares: Prof. G. B. Mathews.—Theories of Magnetic Action upon Light: A. B. Basset, F.R.S.

FRIDAY, NOVEMBER 15.

EPIDEMIOLOGICAL SOCIETY, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—An Exercise Book of Elementary Practical Physics: R. A. Gregory (Macmillan).—Statically Indeterminate Structures and the Principle of Least Work: H. M. Martin (*Engineering* Office).—Mensuration for Senior Students: Prof. A. Lodge (Longmans).—Milk, its Nature and Composition: Dr. C. M. Aikman (Black).—British and European Butterflies and Moths: A. W. Kappel and W. E. Kirby (Nister).—Physiology: Dr. A. MacAlister (S.P.C.K.).—The Structure and Development of the Mosses and Ferns: Prof. D. H. Campbell (Macmillan).—Toxin: "Ouida" (Unwin).—Die Artbildung und Verwandtschaft bei der Schmetterlingen: Dr. G. H. T. Eimer, ii. Theil (Jena, Fischer).—Ethnische Elementargedanken in der Lehre von Menschen: A. Bastian, 2 Vols (Berlin, Weidmann).—North American Shore Birds: D. G. Elliot (Suckling).—Practical Physiology of Plants; F. Darwin and E. H. Acton, 2nd edition (Cambridge University Press).—Hints on the Teaching of Elementary Chemistry in Schools and Science Classes: Prof. Tilden (Longmans).

PAMPHLETS.—Mirifici Logarithmorum Canonis Constructio: J. Nepero, facsimile reprint (Paris, Hermann).—Die Überwindung des Wissenschaftlichen Materialismus: Prof. W. Ostwald (Leipzig, Veit).

SERIALS.—National Review, November (Arnold).—Quarterly Journal of the Geological Society, Vol. li. Part 4, No. 204 (Longmans).—Contemporary Review, November (Isbister).—Quiver, November (Cassell).—Natural Science, November (Rait).—Fortnightly Review, November (Chapman).—Imperial University, College of Agriculture Bulletin, Vol. 2, No. 4 (Tōkyō).

CONTENTS.

THURSDAY, NOVEMBER 14, 1895.

THE EVOLUTION OF THE COSMOS.

Notes on the Nebular Theory in relation to Stellar, Solar, Planetary, Cometary and Geological Phenomena. By William Ford Stanley, F.R.A.S., F.G.S., &c. (London: Kegan Paul, Trench, Trübner, and Co., Limited, 1895.)

THE object of the present treatise is to establish in a modified form the nebular theory of Laplace, by the introduction of some original views which have long occupied the attention of the author. This is an ambitious scheme, and it is a little disquieting to read that authorities whose opinions carry weight did not recommend the communication of these views to the learned societies, whose duty it would have been to weigh and consider them. The reason assigned is, that the views were thought to be too speculative; and after studying them with great attention, we have no hesitation in saying that we hold the advice to have been sound.

Undoubtedly the nebular hypothesis as enunciated by Laplace is on its trial, and does not recommend itself unreservedly to those most capable of judging its merits. It may be admitted that a new working hypothesis would demand and receive great attention. But emendations, to be accepted, must come from those who have made a profound study of mathematical and physical science, and have proved themselves men of original genius. It may be that Mr. Stanley has qualified himself to speak with authority on this difficult subject, and undoubtedly the many references quoted in his volume display considerable reading and research; but the references are too frequently, not to original sources, but to the more popular writings and expositions to be found in the *Proceedings* of the Royal Institution, or in the pages of *Good Words* or the *English Mechanic*, and these authorities are quoted, apparently with as much satisfaction as the *Philosophical Transactions*. It is impossible to resist the impression that the author's scientific information is second-hand. The literary style of the work does nothing to remove this impression, and is incompatible with a complete mastery over the subject. Clearness of expression is wanting; obscure passages, that tax the patience of the reader, abound, and occasionally we come across sentences that defy interpretation altogether. As an example of these latter, we may give the following (p. 42):—"Assuming the pneuma to be a most perfect fluid and elastic system of matter, upon the meeting of two volumes of such matter, independently of any initial rotation it might possess, must have moved under pressure at the meeting plane in every or any direction, which at the time offered the least resistance to the continuity of its initial momentum." Obscurities such as these may possibly prevent the presentation of the author's views exactly as he would have wished. There are many statements which we cannot accept, if we have properly understood them, but which, expressed differently, might command a ready assent.

At the outset of his work, Mr. Stanley gives an historical account of the distinguishing features of the main cosmical theories, which have been elaborated by great minds in the past. The author's want of grasp and poverty of description are in this first chapter most conspicuous. Instead of a full and lucid account of these earlier ideas, which one would naturally expect in a work of this character, the reader must be content to find very meagre and obscure notes on the theories of Descartes, of Kant, of Laplace, or of more modern authorities, as Helmholtz, or of Faye. From this point onward to the end of the book, the author devotes himself to the description of his own views and theories. It has always been admitted, hitherto, by scientific men, that nothing more than a partial solution of the problem presented by the origin of the universe can possibly ever be expected, and, certainly, that our present state of knowledge is inadequate to the task. Laplace, for instance, based his hypothesis on the assumed existence of the sun, and sought to prove no more than the possibility of the formation of a system of planets, such as we see in existence. Mr. Stanley's theories are far more ambitious. Not only does he seek to account for a state of things existing prior to, and leading up to the formation of the sun, but he undertakes to explain such details as geological periods and the disposition of the materials of the earth's crust.

Following the theory which was first suggested by Wright of Durham, that the Milky Way forms one vast originally connected system, Mr. Stanley imagines immense districts in space filled with matter in its "original state." This is assumed to be of an attenuated gaseous character, and since the calculated size of the ultimate atom would leave less than a single specimen to the cubic metre, each one, for reasons which are not apparent, is divided into a large number of parts called "pneumites," which in a state of perfect atomic dissociation give rise to every line in the spectrum of light. The form of the "pneumites" is described in detail; but, inasmuch as our knowledge of the ultimate nature of the atom itself is confessedly imperfect, these speculations are obviously useless from a scientific point of view.

Having formed these arbitrary notions of the elementary condition of matter, existing at a high temperature, Mr. Stanley proceeds to explain the origin of the Milky Way as a vast agglomeration of pneumites, to which he gives the name "pneuma," moving in slow rotation. To account for the flattened form of the Galaxy, it is suggested that two such spheroidal "pneumas" drifted together at an early period, forming at their common surface a somewhat denser plane, over which the more distant parts of the pneumas would spread themselves by the action of their original momenta, while such parts as did not entirely combine would cause an apparent bifurcation. The division of this original "pneuma" system into nebulæ, and ultimately stellar systems, appears to be left to no more dignified cause than chance, aided by condensations brought about by heat radiation. The means by which it is suggested that these bodies kept distinct can only be described as obscure and unsatisfactory, and the attempt to cover with a false appearance of reasoning what must, by the nature of the case, remain matter for the vaguest speculation and assumption, is altogether to be regretted.

The author proceeds to discuss the behaviour of one of these separate condensations which is taken as the

origin of the solar system. It is limited in every direction by the surface at which particles are in equilibrium under the influence of gravity of the solar nebula itself, and of the nearest stellar systems. Under the pressure of the outer portions, a centre of greater density would be formed, to which would be attracted all the matter in the inner parts of the nebula. The outer parts, on the other hand, condensing by radiation, as it is suggested, into comets and meteorites, will not reach the vicinity of the solar nucleus until a much later period, depending on their distances. Some of these will fall into and augment the nebulous sun, while others will become permanent members of the solar system. It is typical of the author's method that either event is left entirely to chance, and it is difficult to see where a line is to be drawn between the sun-forming matter and that which evades the nebulous envelope of the central attracting body. The abrupt disruption of the nebula, thus introduced, offers a most perplexing difficulty.

The process by which the planets come into existence presents precisely the question, to which an answer would be expected in the book before us. It must be said at once that the portion of the book dealing with this question is most unsatisfactory. In addition to the obscurity of style, to which allusion has already been made, the unfortunate arrangement of the subject-matter makes it quite impossible to gain any clear insight into the author's views as a connected whole. Mr. Stanley appears to adopt the theory of Laplace in its main features, not because he has any novel arguments to urge in its support, nor on account of the reasons which have hitherto led to its tentative acceptance, but because, in his opinion, no other theory heretofore offered possesses any reasonable probability. "Nevertheless," he says (p. 65), "it is not probable that our system was formed by any simple single mechanical effect of the action of forces upon surrounding universal matter, as generally assumed in special theories, but rather that all possible conditions were active, that may have conspired to produce the final results." Thus, for example, according to the theory of Laplace, the author thinks there should be a simple relation connecting the masses of the planets with their respective distances from the sun. He therefore attempts to explain the irregularities observed in the masses of the planets, by supposing them to be caused by the precipitation into the solar nebula of that matter, which at a much earlier period condensed by itself at the outermost parts of the solar "pneuma." Such a process implying the previous formation of masses, of variable amount, and operating irregularly and intermittently, may account for the existence of planets greatly differing in size; but, at the best, the difficulty is only removed from one place to another. It seems equally impossible to agree with the author that the plane in which the planets revolve, has been determined by the superior attraction of the two nearest stars. For both this plane and the equatorial plane of the sun should apparently preserve the direction impressed by the moment of momentum of the original solar nebula.

Space will not permit us to follow further Mr. Stanley's notions of the processes of planetary evolution or the effects which, it is suggested, the successive formation of planets had upon geological periods. It can only be said that the author toys with millions of years in a manner which possibly amused himself, but which can scarcely be edifying to the serious student. Unless the leading points of Laplace's theory can be placed practically beyond question, the consideration of details can have no scientific interest. And Mr. Stanley could hardly expect to rescue from its present position of doubt, and to place on a secure basis a theory, on the merits of which the ablest mathematicians and physicists have been unable to arrive at a definite conclusion. We have already intimated our opinion that the author's knowledge of mathematics and physics is slight. In confirmation of this view, we might draw attention to his treatment of the problem of finding the volume of a ring (p. 82), and to a bold assertion, on p. 190, concerning the increase of vapour tension in the atmosphere. We might, too, point to his contemptuous rejection of the theory, well supported by the highest authority, that the interior of the earth is not fluid. He is also singularly unhappy in refusing to accept Prof. G. Darwin's demonstration, that the earth formerly rotated at a much higher velocity than at present, because the study of the effects of tidal friction has always appeared to give direct evidence in favour of the probability of the nebular hypothesis.

W. E. P.

ELEMENTARY HIEROGLYPHICS.

First Steps in Egyptian: a Book for Beginners. By E. A. Wallis Budge, Litt.D., Keeper of the Egyptian and Assyrian Antiquities, British Museum. (London: Kegan Paul, Trench, Trübner, and Co., 1895.)

A REVIEW of a book dealing with the laws and structure of language may perhaps at first sight appear out of place in a journal devoted to science. A moment's consideration, however, will convince the reader that the book, the title of which stands at the head of this column, may be regarded as an exception to the rule. Very little was known of ancient Egypt until, at the beginning of the present century, the genius of Young and of Champollion led to the decipherment of the native inscriptions. Since that time, however, Egyptology has attracted many workers, and to the results that have followed the first decipherment the student of anthropology is perhaps even more indebted than the philologist; for while the language in itself proved unattractive in conquence of its somewhat chaotic structure, the subject-matter revealed was of the very highest importance. The key to the hieroglyphics, in fact, admitted the anthropologist and man of science to the study of the legends and beliefs, the daily life and customs of a people, whose history commences more than four thousand years before our era.

The truth of this statement is confirmed by the immense mass of literature that has within the last few years grown up around the records and remains of ancient Egypt. The man of science has made good use of his rich vein of fresh material, histories have followed quickly on one another's heels, while many of the Egyptian sacred texts and legends have appeared from time to time in the form of short stories and translations; in fact, the public has been amply provided with the means for acquiring a general knowledge of Egyp-

tian science, history, and literature. But many people are not content to get their information entirely at second-hand. A winter spent in Cairo, or even a visit to a local museum, has perhaps tempted them to try to find out for themselves how the Egyptians recorded the legends and history of which they had read, or wrote down the prayers and ritual of which they had seen translations. Few, however, have found it easy hitherto to satisfy their curiosity, for the standard grammars and dictionaries of the language, with which the trained Egyptologist works, are either too costly or too stiff for the beginner, while editions of texts generally presuppose a knowledge of the language, and in many cases must be unearthed from the journals of learned societies. It is not surprising, therefore, to find that many a beginner has been discouraged by the great outlay, both of time and money, that must precede the commencement of his studies.

To any one who has had this experience, we would recommend Dr. Wallis Budge's "First Steps in Egyptian." Here the beginner who is anxious to tackle for himself the interpretation of Egyptian hieroglyphics, and to control the statements of scientific or popular writers, has the means placed at his disposal between the covers of a single book; and, should he subsequently wish to continue his studies, he will find himself enabled by its help to use with advantage the more advanced grammars he may come across in English, French, or German. A brief description of its contents will serve to indicate its general scope and character.

The book consists of two parts—the first containing an introduction, the second the texts. In the former, Dr. Budge begins by dismissing in a few paragraphs the external aspect of the subject, briefly referring to the history of Egyptian decipherment, and describing the manner in which inscriptions are written; he then passes to a detailed explanation of the twofold functions performed by the hieroglyphic signs, as ideographs and phonetics, and appends a list of the common signs with their phonetic values; the function of determinatives is next explained, and their use illustrated by a number of examples. The reader is then in a position to appreciate an analysis of an extract from a text, and an explanation of the methods by which its meaning may be ascertained. The rest of the introduction deals successively with pronouns, nouns, the article, adjectives, numbers, measures, divisions of time, the year, the verb, the adverb, prepositions and conjunctions, and particles, in each section of which any rule or statement is illustrated by a number of examples, and concludes with a list of common words and a list of the names of Egyptian gods and goddesses. Part ii. contains a series of some thirty texts and extracts, ranging from the Third Dynasty to the reign of Ptolemy V., and these are followed by a few untransliterated and untranslated texts, which the reader is intended to work out with the help of a short glossary at the end of the book.

In his selection of texts we think the author has been wise to look out for passages interesting in themselves, for by this means the reader's attention is secured. The translations of some of the shorter extracts are well worthy of quotation, some of the "Maxims of *Ani*," for instance, inculcating a lofty morality, while others show a shrewd knowledge of the world. "Take to thyself a wife while she is young, and she will make for thee thy son." "The time [once] past, one seeketh to grasp others [in vain]." "Enter thou not among the many, that thy name may not stink." "Answer thou not an angry master; speak that which is soft while he is uttering that which is of wrath." "Festal cries are abhorred by the sanctuary of God. Make thou supplication with a loving heart, its petitions being all in secret, and He will perform thy affairs, He will hear that which thou sayest, He will receive thy offerings." "Do not put thyself into the house of drinking beer. An evil thing are the words reported second-hand coming forth from thy mouth, thou not knowing they have been said by thee. Having fallen, thy members are broken, another giveth not the hand to thee. Thy companions [in] drink stand up, saying 'away with this drunkard.'" "Death cometh; it seizeth the babe which is on the breast of his mother as well as him that hath become an old man." "[When] thy messenger [of death] cometh to thee to carry thee off, be thou found by him ready." We have not space to do justice to the varied selection of historical and religious texts here collected, but may refer the reader especially to the quaint legend of "The Destruction of Mankind," and to *Tuauu-f-se-Kharthai's* humorous praise of the literary life and its rewards, in which he contrasts it with the unattractive trades of the blacksmith, "who stinketh more than the eggs of fish"; of the barber, "who worketh violently by his two arms to fill his belly"; of the weaver, "who is more wretched than a woman, whose legs are under him at the door of his heart, who breatheth not the air"; of the dyer, "whose fingers stink [with] the smell of the keeper of dead bodies"; and of the shoemaker, "who is the most unfortunate of all, for he chattereth everlastingly . . . [and] feedeth upon leather." We will conclude with a few lines from one of the untranslated texts, the touching address to the deceased lady *Ta-khert-p-uru-abtu*, which may be summarised as follows:—

"O thou triumphant one! thy soul liveth in heaven with the god Rā. Thy *double* has had offerings made to it among the gods. Thy beatified form is glorious among the shining ones. Thy house is filled with children and a husband, who as they follow thee weep. Thy children are rewarded by meeting thee for all they have done to thy *double*. Thou hast been buried rightly and gloriously, and they have placed thy *double* at the west of Thebes, opposite thy fellow-citizens. Thy tomb shall never be ravished, thy bandages shall never be stripped off, and thy body shall never suffer harm. Thy soul flieth towards heaven to meet the soul of the gods. . . . Thy life shall endure for ever, thy majesty shall be eternal, and thou shalt enjoy an endless number of festival-cycles, each of which shall endure for 120 years!"

It must not be supposed from what we have said that the book opens up a royal road to knowledge. No new language can be acquired without continuous work and perseverance, and Egyptian is far from being an exception to the rule. Hitherto, however, in addition to encountering the actual difficulties of the language, the beginner has been handicapped by a long and often unsuccessful search for his materials; his first steps, in fact, were unnecessarily arduous, and in making these more easy Dr. Budge will have deservedly earned his gratitude.

THE CLASSIFICATION OF ROCKS.

An Introduction to the Study of Rocks. By L. Fletcher. (British Museum (Natural History) Mineral Department, 1895.)

HAVING received from the facile pen of Mr. Fletcher a guide to the Mineral Gallery of the British Museum, and an introduction to the Collections of Minerals and Meteorites which it contains (works of a very high order from their simple lucidity as well as their thoroughness and accuracy) the student has looked forward to a companion work on the Rock Collection, from the same writer. This work has now made its appearance, and is no whit behind its fellows in outward aspect, being printed in clean, clear type, on good white paper, cheap, not too bulky, and attractive in its general appearance.

A large part of the work is taken up with an essay on classification, which will certainly tend to impress the student with the care that must be used in seizing on essential characters, the numerous pitfalls to be avoided, and the necessity of employing every instrument of research available in the study of rocks. After some preliminary paragraphs on the varied points of interest which rocks present; on the chief characters presented by the two constituents of rocks, minerals and amorphous matter; and on their ordinary modes of origin; the author observes that rock-masses vary so much from point to point, that "similarity, not identity" of characters can alone be aimed at in a classification. He strives to recognise the existence of "*petrical individuals*," but, owing to variation in different parts, to alteration, inclusion, and denudation, fails to reach the ideal, and is compelled to state that "petrical individuals have rarely, if ever, existed." We can hardly realise, however, that the inclusion of fossils or pieces of foreign rocks, which seem to trouble the orderly mind of the author, can have any real bearing on nomenclature; a boy is no less a boy if he happens to have swallowed a button. The outcome of this discussion is that "a rock-name is only required by the mineralogist for the purpose of indicating the *kind* of rock, not the particular rock-mass itself."

An admirable account is then given of "lithical characters" observed in hand specimens, both in relation to their individual constituents and to their aggregation or structure, and of the "petrical characters," which are only to be observed on a large scale in the field. A very useful term is here introduced—"merocrystalline," which is to be correlative with holocrystalline; all petrologists will be grateful for this substitute for semi-crystalline and the other unsatisfactory terms that they have been compelled to employ under protest. Taking the characters here specified, the author employs them to construct a tentative classification of a set of typical rocks, by linking into one group those which have several of these important characters in common. The first scheme attained by this method is in part natural, in that it brings together those "rocks which are composite in kind of material, holocrystalline, and without directional lithical characters," such as granite, syenite, diorite, dolerite, and euphotide. But it is also in part artificial, as, for instance, when it brings together gneiss, shale, and slate because they possess directional characters, and coal, clay, and phonolite because they are compact though composite. Mr. Fletcher points out that "directionality has been useful, however, in enabling us to bring together the rocks belonging to the several kinds"; but that things thus wedded are to be so quickly divorced is, we take it, his method of enforcing the necessity for most careful selection of essential characters in classification. The primary essential, when hit upon, turns out to be mode of origin.

From this point things go more smoothly, and the rocks fall into a grouping which is, for the most part, natural; want of complete knowledge on such subjects as the origin of the crystalline schists still, however, leaves us in difficulties in classifying these rocks, and we are compelled to place in an artificial group many which differ widely in their methods of origin.

In developing the natural grouping finally adopted, the history of the granite and basalt controversies is succinctly told, and a set of useful definitions and descriptions of the chief types of rocks is given. The work closes with a brief syllabus of these types, which have, through the devious course of trial and error, at last found rest in natural and fairly well-defined groups.

OUR BOOK SHELF.

Facts about Processes, Pigments and Vehicles; a Manual for Art Students. By A. P. Laurie, M.A., B.Sc. (London: Macmillan and Co., 1895.)

IN the majority of cases when a student of painting has seriously entered upon his work in a school of art, he has no wish, he makes no attempt to investigate the chemical and physical properties of the materials he employs. He is content to copy the practice of his teachers and fellow-learners; facility in working and immediate effectiveness are all he demands. He may even go so far as to resent the intrusion of science into the domain of art. To ask a painter to study exhaustively the chemistry of the materials and processes of painting would be unreasonable, for a whole-hearted devotion to the prime business of his life must be his first concern. Nor can an adequate grasp of the difficult and varied problems offered by pigments and vehicles and painting-grounds be acquired by listening to a few lectures, witnessing a few experiments, and reading a few chapters in a manual. The author of the little book before us makes a very modest demand upon the time and patience of the student of painting. Here are no symbols and formulæ to repel the uninitiated, no tables of constants, no complex theories of reaction and change. Mr. Laurie's readers are first furnished with a set of easy experiments which have been devised to show in an obvious way the nature and treatment of the chief pigments and vehicles. Then, in part ii., some notes on methods of painting in tempera, fresco, water, and oil are given, while the volume concludes with a glossary of pigments and a list of the chemicals and apparatus needed for carrying out the experimental work described in the earlier chapters of the book. There is one section of the volume which seems somewhat incongruous—a description of "drawing for process" and an endeavour to estimate the artistic value of the leading methods of photographic reproduction. Mr. Laurie will doubtless effect some improvements in a second edition—a little more attention to literary style is desirable. The late Mr. Gambier Parry of Highnam Court would have been surprised to find himself described as French. There are, indeed, very few slips or errors in this little volume—very few statements and explanations with which the writer of this notice does not agree.

A. H. CHURCH.

Practical Proofs of Chemical Laws: a Course of Experiments upon the Combining Proportions of the Chemical Elements. By Vaughan Cornish, M.Sc. (London: Longmans, Green, and Co., 1895.)

THIS small work is essentially a product of the modern efforts to teach science by a scientific method.

The author has endeavoured to give, in some ninety-two pages, clear and sufficient instructions for the experimental verification of the great quantitative laws upon which chemistry is based, and he has fully succeeded.

Nothing could be better calculated to lend interest to the work than the author's plan of quoting the results which were considered sufficient to establish these laws in the early days of our science; and the comparison of experimental data, obtained by the student, with the classical results of the great pioneers of chemistry, must lend a reality and zest to his efforts.

Used in its proper place, with students who have been well trained in general experimental science, and under the supervision of a capable teacher, there is no reason to suppose that the somewhat dogmatic statement of chemical laws will have any ill result.

The statement of the law of constant proportion given on p. 3—"this proportion remains constant in compounds which contain also other elements"—is so worded as to convey a wrong impression. It might be thought, for instance, that the proportion obtaining between potassium and chlorine in potassium chloride would remain the same in potassium chloroplatinate, which contains also another element platinum, and a reference to chapter v. would confirm this impression. It is evident that this statement requires remodelling.

Certain slips of a different type have found their way into the text. Thus, "*hollow glass-rod*" is mentioned on p. 52; and on p. 62, it is advised to treat silver with "pure strong hydrochloric acid" in order to convert it into silver chloride. Notwithstanding these minor defects, the book may be safely commended as embodying a well-thought-out and feasible plan of work. T.

Great Astronomers. By Sir Robert S. Ball, F.R.S. Pp. 372. (London: Isbister and Co., 1895.)

THE greater part of this book consists of *réchauffées* articles from *Good Words* and other publications. At the present day there is a large public curious to know biographical details, so no doubt the book will find many appreciative readers. The astronomers whose lives are portrayed are Ptolemy, Copernicus, Tycho Brahe, Galileo, Kepler, Newton, Flamsteed, Halley, Bradley, William and John Herschel, Laplace, Brinkley, the Earl of Rosse, Airy, Hamilton, Le Verrier, and Adams. It need hardly be said that the serious student of astronomy will find little in this book not already familiar to him; the volume is intended for the popular mind, and therefore much of it is small talk of the kind in which the general public revels. When the lives of eighteen astronomers are described in a volume of less than four hundred pages, as they are in this book, it is needless to say that only a few of the features characteristic of each can be presented. Sir Robert Ball has, however, selected the chief features in the lives and works of the great men who form his subjects, and his sketches, though verbose in parts, bring to light a few new facts in which astronomers generally will be interested. The book contains numerous illustrations, many of them new. The illustrations chiefly represent the astronomers described, and their houses, observatories, and instruments. We cannot understand, however, why some of them are in the book at all; for instance, with the sketch of the Earl of Rosse we find pictures of Birr Castle; The Mall, Parsonstown; and the Roman Catholic Church at Parsonstown. The connection of these views with "Great Astronomers" is much less reasonable than that between cats and clover.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Sir Robert Ball and "The Cause of an Ice Age."

I SHOULD like to correct one statement in my long letter in NATURE of October 17. I there said that Sir Robert Ball had not withdrawn his claim to the discovery of the law of distribution of summer and winter temperature in each hemisphere, which had in fact been previously published by Wiener. I am reminded by Mr. Kendall that I had overlooked a second edition of the book in which credit is duly assigned to Wiener. Thereby hangs a tale. I have looked in vain through Low's well-known list for any trace of a second edition. I also looked through the British Museum Catalogue without any result, and inquired in the Copyright Office in that establishment, and was told that no such book had reached the Museum. Lastly, the Museum people tell me they have applied to the publisher for the book, and have received the reply that it is only a re-issue, and not a new edition with new matter in it.

I am further told by the Museum officials, that he has thereby incurred a penalty of £5 for non-compliance with the Copyright Act. It was by an oversight of his, therefore, that this second edition has been overlooked by myself and, probably, by others.

In this second edition, Sir R. Ball, after unwittingly wearing the nimbus for six years, gives up his oft-repeated claim to be the discoverer of the law in question, and attributes it to Wiener. As the publication of his discovery was the alleged reason for writing the book, he had now to find another excuse, and did so by reiterating the unjust accusation he had made against Croll of having ignored the disparity between the sun-heat of summer and winter, and thus necessitating the writing of a work to set the world right on the matter.

As long ago as 1891, Mr. Noble had called attention to this injustice, and shown that Croll had nowhere made the mistake attributed to him, and quoted passages from pages 55 and 86–7 of "Climate and Time," to show that he was perfectly aware of the real conditions. Although Croll nowhere cites the actual numbers 63 and 37, or 3·93768 and 2·34550 as Wiener gives them, it is odd that in calculating the amount of sunshine received at Edinburgh in summer and winter respectively, he does give the numbers 7 to 4, that is, 63 : 36, and "Climate and Time" was published four years before Wiener's "Memoir."

It is quite true that Croll does not use these figures in his calculations as Dr. Ball does. For him they would be mere academic numbers, since he knew, as we know, that the problem to be solved depends much on the proportions of the differential temperature of different latitudes at different seasons, and little or nothing on the proportions of the temperatures at different seasons of a whole hemisphere lumped together.

Since the above was written, Mr. Hobson has replied to my previous note, complaining that I have converged attention upon the now famous law, which was supposed to be Sir R. Ball's own child, and have not referred to the effects of varying eccentricity, which were everybody's property. He forgets that I was criticising Dr. Ball, who habitually claims the law in question as the *causa causans* of an Ice age, and especially refers to this invariable and constant factor as "the following theorem which constitutes *the essence of the astronomical theory of an Ice age.*"

The value of this essential factor of the problem being the matter in dispute, I presume Mr. Hobson wrote his letter to illuminate your readers, and not merely to engage in a profitless polemic. If so, perhaps he will do me the favour of meeting the following case.

(1) Wiener's law is not disputed. It represents the proportions between the *sum* of all the sun-heat received in either hemisphere in summer and winter respectively.

(2) Sir R. Ball makes it apply not only to the whole hemisphere, but to different zones in the hemisphere, and notably to Britain (see "A Cause for an Ice Age," new edition, pp. 127–131). Will Mr. Hobson support this astounding conclusion?

(3) In the zone between the tropics there is perpetual summer, and it absorbs one-half of the sun's heat received on the earth in equal proportions in the two seasons. Here, therefore, the proportions of sun-heat are not 63 : 37, but 50 : 50. There-

fore Wiener's law is not true of this zone taken apart. If we subtract the sun-heat received in this zone where glacial conditions never existed, we shall find that the proportions in the temperate and polar zones combined are not 63 to 37, but 38 to 12. So that Wiener's law is not true of these zones where glacial conditions alone existed. If, instead of taking the tropics, we take the area limited by the parallels of 45°, which is a better boundary for the district displaying glacial phenomena, the disparity is still greater. At Edinburgh, as Croll long ago said, the proportions are about 3 to 1. Does Mr. Hobson dispute this?

(4) Dr. Ball nowhere connects Wiener's law as a cause with the Glacial age as an effect *by proof of any kind*. He merely offers us certain *obiter dicta*, and argues that if the present proportions of sun-heat were distributed over a winter of 199 days and a summer of 166 days, we should have a glacial climate in Britain. Since the proportions of sun-heat actually recorded in Britain at this moment in our 199 coldest and 166 warmest days respectively show a far greater disparity than that represented by these figures, I may, I think, ask if Mr. Hobson admits this *reductio ad absurdum* of Sir Robert Ball's argument to be valid?

(5) Lastly. For the first time, Mr. Culverwell has applied numerical tests and methods to the problem of discovering the actual and not the hypothetical results on climate caused by a varying eccentricity of the earth's orbit. He has done so by comparing the actual sun-heat received by each latitude now, and contrasting it with the actual sun-heat received by the same latitude in the time of greatest eccentricity, and has shown that the limits of variation do not amount to more than can be measured by removing a parallel of latitude from 3½ to 4 degrees. This to some of us is absolutely conclusive, not only against Dr. Ball's arguments, but against all astronomical theories, including Croll's.

The real point and meaning of my letters is that in regard to the astronomical theory of an Ice age all the kind of reasoning employed by Sir R. Ball and its consequences are fallacious. They have been swept away and shown to be worthless by Mr. Culverwell's method of solving the problem, which is inductive and decisive, and which rigorously proves that Sir Robert Ball's results are as extravagantly baseless as his method is unfruitful. This being so, it is most clearly incumbent upon the Lowndean Professor either to answer his accomplished critic or to withdraw his book, which is only misleading the unwary by having its mistaken and shattered arguments sheltered under the Astronomical Chair at Cambridge. It ought certainly to have no place in a series entitled "Modern Science," where ascertained results and not ingenious fallacies ought to find a place. Nor ought Mr. Kegan Paul's name to appear on its title-page as a guarantee of its scientific soundness.

The Athenæum Club, October 29. HENRY H. HOWORTH.

Curious Aerial or Subterranean Sounds.

PROF. G. H. DARWIN, in NATURE for October 31, p. 650, asks for information as to the "Barisàl guns." The name is derived from Barisàl or Burrisal, a town in the eastern part of the Gangetic delta, and the best and most recent account of the sounds known as the "Barisàl guns" is to be found in the report of a sub-committee of the Asiatic Society of Bengal, published in the *Proceedings* of that Society for 1889, p. 199.

The great difficulty in the way of accepting the suggestions of Messrs. Meldola and Davison (NATURE, November 7, p. 4), that earthquake shocks are the cause of the sounds, is the restriction of the "Barisàl Guns," so far as is known, to a comparatively small area, where earthquakes are of rare occurrence, and to a particular season of the year.

W. T. BLANFORD.

[*Translated by Prof. G. H. Darwin.*]

AN article, by Prof. G. H. Darwin, on "Barisàl Guns and Mistpouffers" appeared in NATURE for October 31. Summarising a letter in which I drew his attention to this phenomenon, he mentions two sources for these mysterious sounds, which my friend M. Rutot and I have considered as possible, namely that the origin is entirely terrestrial, or that it is a special phenomenon of atmospheric electricity. It is as well, perhaps, also to point out another purely atmospheric source, viz. that it may arise from the abrupt displacement of a mass of superheated air in unstable equilibrium, which rises suddenly in the atmosphere.

This was the explanation given to M. Lancaster by the late M. Houzeau, the astronomer, on the former sending him my first notes on this phenomenon, in about 1881. M. Houzeau also stated that he had himself observed the noises, but that he could not suggest any more plausible explanation than the above.

In confirmation of this hypothesis, I would remark that *this year* the mysterious detonations were heard up to the end of September, and even up to the beginning of October, not only by me but by several of my friends and correspondents; this is much later in the year than usual. Now great and unusual heat prevailed this year during the whole autumn, and this coincidence affords a strong support to the theory of an origin arising from certain conditions of rise of temperature.

Sailors of the port of Ostend assert that "Mistpouffers" prevail over the whole of the North Sea as far as Iceland, and they consider them to be a sign of fine weather, with calms and heat.

The mysterious noises, mentioned to me by Mr. Clement Reid, which are heard on Dartmoor and in Scotland near the Highland Fault, are not perhaps exactly comparable with "Mistpouffers"; for Mr. Reid writes to me that these sounds are probably associated with those incessant tremors of the earth's crust, which are well known in these districts. With respect to sounds of this peculiar kind, readers of NATURE will find an interesting note by Mr. Charles Davison, entitled "On Earthquake Sounds," in the *Geological Magazine* for May 1892.

I might add many interesting data concerning "Mistpouffers," but I have promised to reserve them for the Belgian magazine *Ciel et Terre*, edited by M. Lancaster. In that journal, the readers of NATURE who are interested in this subject, will shortly find a complete account of the papers which have come to my knowledge; to which they will doubtless be able to add a number of facts and observations, which will prove of great service for the scientific study of the question.

ERNEST VAN DEN BROECK.

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I HAVE heard many queer noises in lonely spots, and wish I had made note of the time and place and circumstances. But though I have few exact facts and figures, I have a very distinct recollection of many such observations, some of which are a direct answer to the question asked by Prof. Darwin in your number of October 31, while others seem to have a bearing upon it.

I have sometimes heard on the mountains north of the great Craven Faults, from which I looked over low ground towards Morecambe Bay, what I always took to be the sound of heavy guns somewhere out seaward. They were not, however, repeated at such intervals, nor for so long a time as to support the view that it was the sound of artillery practice; and, when I made inquiries from friends who resided in the district, I never learned that there was anything of the sort going on. The sound struck me as peculiar, but I could not find any satisfactory explanation of it. I considered many possibilities. First, there was the general question of the different transmission of such sounds according to the state of the atmosphere. Fog, for instance, affects it. In the particular case I have mentioned, I knew there were great quarries in various places within a few miles, and I had always before me the possibility of my having heard the sound of blasting echoed by some combination of cliffs to where I was.

The noises I heard were just such as are produced by the thud of the wave as it fills a cave. The muffled sound of the impact of water is heard a long way off. An idea of its force may be gained from cases in which the air, instead of being compressed in the hollow of the rock, finds an opening to the surface of the ground above, and rushes out, sometimes followed by a spout of spray. Its recurrence is irregular, and it lasts only for the short time when the rise and fall of the waves just fills and empties the cave. The direction of the transmission of this sound to long distances is still more uncertain.

In the case of the air-thuds on the Yorkshire Fells this explanation is extremely improbable, and the "guns of Barisàl," so named from the town and river of that name, boom across the flat delta of the Ganges, where there can be no cliffs or caves. What is really common to the two areas suggests another possible explanation.

The sound of the first blow of the curled wave upon the shore or on the sea, and of the outburst of the great volume of air included in its fold, is carried an immense distance. I have heard it much resemble heavy guns. It is exceptional and irregularly intermittent. It is only when the tide has reached one part of

the long, flat shore, that the right combination occurs. For, when there is a ground swell on, the waves do not roll in continuously, but come in groups, and therefore we require the coincidence of the higher waves and the right minute on the shore.

Now, Morecambe Bay has a long flat shore, over which the tide comes in so fast that it has been known to overtake a coach-and-four. It is open to the south-west wind and the Irish Channel tide. The time when the "Barisàl guns" are heard is when the great tidal wave is rushing up the estuaries in the Bay of Bengal. This is a very suggestive coincidence.

Before we go further in our investigation of air-thuds, it would be of great help if we would get some exact data as to the distance at which the sound of great guns, of blasting, or of waves, can be proved to have been heard. So far I have endeavoured to explain such sounds by surface action. I believe, however, so strongly in the rapidity and constant recurrence of earth-movements which must produce sound, that I would add a few words upon that point.

To begin with small sounds. When the sun is setting and the shadows of the mountain climb up the screes or talus, each part rapidly passes from sunshine into shade, and often into very cold shade. In such circumstances it is not uncommon to hear a crepitation among the fragments. This is quite in accord with the view that the downward travel of the screes is largely due to diurnal changes of temperature affecting the fragments of which they are composed. More rarely bangs are heard among the crags in similar circumstances. The ticking of the firedogs and iron-work of a grate when the fire has gone out, and the sudden and terrifying crack of the oak-wainscoted room, are familiar examples of the same kind of thing. In frost, of course, such noisy ruptures are common.

Now as joints in rocks are surface phenomena, due to shrinkage, detonations accompanying such disruptions should be often heard. Under the artificially-produced conditions of mining they are frequently heard. In the limestone quarry, from which the black marble of Dent is procured, the workmen found that, when they were quarrying the lower beds, and struck the rock with a pick or bar, fragments flew up into the air with a greater force than could be due to the blow of the pick, and in an unexpected direction. Also, when the tunnel was being made above Ribble Head, and the workmen were engaged upon the bed of rock which formed the floor of the tunnel, pieces used to burst off with a loud noise, so that some of them thought that they had discovered a detonating shale. The explanation in both cases was that the hard thin bed which shelled off in that unexpected manner, rested on compressible shale, which, behaving as a fluid, transmitted the pressure due to the sides of the quarry or the wall of the tunnel, squeezed up the floor where the rock had been removed, and produced what in a coal mine would be called a "creep." The thin bed of hard rock above the shale rose in a slight arch over the upthrust shale, and was thrown into a state of tension, so that, when it was struck, chips, flakes, and sometimes larger pieces, would fly off. Phillips pointed out that "the removal of one side of a vein would leave the remaining side in a condition of strain resembling that of a strung bow, with a tendency to bulge outward into the workings," and it is known that from such a surface, especially when covered with a coating of crystalline vein-stuff, fragments fly off with cracks and explosions of various degrees of intensity. Earth-movements and the action of subterranean waters are continually opening out channels in which all these processes which produce strained surfaces and consequent explosions are going on. The widespread belief that fairy or goblin miners are heard working deep in the bowels of the earth probably arises from these natural rock-burstings, which are, from the nature of the case, more apt to occur along the line of lodes. I have myself been advised to go in for certain mining speculations because the sound of workmen's tools had been heard beneath the ground.

As on a small scale along lines of tension, artificially or naturally produced, so on a large scale along the lines of strain due to the great earth-movements, which are continually going on, analogous disruptions must repeatedly occur. When it is on a great scale, and the tremors and throws accompanying it have been observed, it is called an earthquake; when the noise only of the break is heard, it is unrecorded, because of the difficulty of distinguishing one air-thud from another. It must be a phenomenon of not uncommon occurrence along the lines of more rapid earth-movement, for we must bear in mind in all such inquiries that time is an element in the bending of rocks. In the cases I mentioned above, it is the rapidity of the action due to the artificial removal of the mass that causes the rock to break rather than to sag or bend, and retain its curved form. This last we see commonly among the contorted strata where nature has applied the pressure more gradually; but we also see evidence of more sudden movement in faults and slickensides and similar phenomena, all of which are going on still, and must be accompanied by sounds could we only detect them.

T. McKenny Hughes.

Cactaceæ in the Galapagos Islands.

In my notice (Nature, p. 623) of Dr. Baur's botanical collections from the Galapagos Islands, I intended to add a few words respecting the Cactaceæ, but forgot it at the last moment. This natural order of plants forms the most conspicuous feature in the vegetation of some of the islands, as may be seen in the excellent views illustrating the cruise of the U.S. ship *Albatross*; yet Darwin, so far as I can discover, is the only naturalist who ever brought away any specimens, or contributed to any more exact knowledge than can be got from photographs on a very small scale. The presence and abundance of Cactaceæ in these islands is highly interesting, especially in relation to the age and origin of the flora, and to the fact that none exist in Juan Fernandez, though they abound in Chili. They are also of great importance to the animal kingdom during long droughts, as they are then the only source of water. As we learn from Darwin, the succulent branches are eagerly devoured by the large tortoises, lizards, and various other animals. He found that lizards four feet in length were easily enticed whenever he threw them a piece of a branch, and small birds would come within a few feet of him and peck at one end whilst a lizard was eating at the other.[1] Darwin also regarded the Cactaceæ as a source of food; and it is noteworthy that animals were mainly dependent on the branches broken off by wind. *Opuntia galapageia* was found by Darwin on James's Island, growing from six to ten feet high, with a trunk a foot in diameter, and so densely covered with strong spines as to be protected from destruction by predatory animals. The younger branches bear only long elastic bristles. Dr. N. J. Andersson, a Swedish botanist, who visited the islands in 1851, states (Eugenies Resa, "Botanik," p. 95) that this cactus grows in all the islands, and he adds that he observed at least four or five other species, but had not time to collect specimens or to sketch them. In another place ("Linnæa," xxxi., 1861–2, pp. 571–631) he particularly mentions the *Opuntia* growing in lava where nothing else would grow, forming huge candelabra-like objects with pretty red, shining fruits. It is evident, too, from the photographic views reproduced in the "General Sketch of the Expedition of the *Albatross*," that one (or more) species of *Cereus* attains a height of ten or twelve feet, and is equally prominent in the landscape. Perhaps the next botanist who visits the islands may find time to study the Cactaceæ. But when will any Government think it of sufficient importance to attach a really qualified botanist to such expeditions? I ought to add that Dr. Baur is not a botanist, but he appears to have done his best as a botanical collector.

W. Botting Hemsley.

Slow Lightning.

As far as I know, the first description of slow lightning occurs in your issue of November 7. It must be very rare, for I have never met any one who would readily believe in its existence. I write to testify to the accuracy of Mr. Crawford's description, though I have not seen it quite as slow as the flash which he timed. The best example that I ever saw was in a storm over London some eighteen years ago. "A thick stream poured down, in the sort of curve which liquid takes from a kettle, and was then slowly joined by a similar stream from the opposite direction, the united stream then continuing its slow course downwards. I was not where I could see the end of it. The peculiarities—the breadth of the streams, and their deliberate motion—could scarcely be an optical delusion. The streams did not appear to me as "chains."

I have observed lightning all my life, and since it has begun to be photographed, I have been looking out for pictures of the various types. I hope we may get some picture of this, and

[1] See *Magazine of Zoology and Botany*, i. (1837), p. 467, where Prof. Henslow describes and figures *Opuntia galapageia*.

also of the sheaf form, which I have seen in storms directly overhead, the flash being like two brushes discharging in opposite directions, recalling the classical representations of the lightning in the hand of Jupiter. ROBERT BRIDGES.

Yattendon, Newbury, November 8.

An Early Reference to Hydractinia?

IN Swammerdam's letter to Thevenot on the anatomy of the Hermit Crab, there seems to be a reference to Hydractinia. The passage ("Biblia Naturæ," Leyden, 1737, i. 197) runs thus:—"Maximas tamen omnes [conchas] *Fuci marini quædam species, punctis vel apicibus minutis assurgens*, obtegebat eousque; ut tota nonnullarum figura obscurata & deformata esset; neque spiralium, quibus gaudent, convolutionum ulla posset conspici."

I venture to suggest that the words in italics fairly (though, of course, not literally) correspond to the "chitinous crust covered with numerous grooved and serrated spines" of Hincks ("Brit. Hydroid Zoophytes," i. 23, 24). The obliteration by Hydractinia of the whorls of shells tenanted by the Hermit Crab is well-known. Specimens showing such obliteration may be seen in the Natural History Museum, South Kensington.

Harringay, N. HENRY SCHERREN.

Rooks and Walnuts.

MR. REID'S remarks on rooks carrying off acorns, suggests my mentioning that they are great depredators of my walnuts. They come early in the morning, attack the walnuts on the trees, and carry them off to an adjoining field, where they punch a hole in the shell and extract the contents.

They build on several groups of elms in Ealing, and on one row of trees close to Christ Church they come regularly at Christmas to see what repairs are required; but one tree, which has an electric wire running through it, they now entirely avoid.

GEORGE HENSLOW.

A Substitute for Sulphuretted Hydrogen.

HAS "Rusticus" (see vol. lii. p. 597) heard of liquefied H_2S? I have tried it, and find it works admirably. Unlike ammonium thio-acetate, it can be obtained from any of the usual chemical dealers; a bottle containing a pound, = 11 cubic feet, can be had for a few shillings. It is always on hand when required, and entirely dispenses with the old H_2S apparatus and its abominations. A very great desideratum is the purity of the liquefied gas. CHEMICUS.

A GERMAN IMPERIAL INSTITUTE.

IN his presidential address to the British Association at Ipswich, reported in NATURE on September 12, Sir Douglas Galton referred to the efforts made by the German Government and Municipalities to advance scientific knowledge and promote research. In his statement that the "Royal Technical High School" at Charlottenburg "casts into shade the facilities for education in the various Polytechnics which we are now establishing in London," he scarcely appreciates the radical distinction between the German and London institutions, which accidentally bear the same name, but which are wholly different in purpose and organisation. But his remarks on the Reichsanstalt of Berlin are so suggestive and so full of interest, that I was eager to have the opportunity of visiting the Institute, and was glad within the last week or so to be able, during a brief stay in Berlin, to make myself better acquainted with its work.

The Institute, as its name implies, is an "Imperial Institute," as distinguished from the Polytechnicum, which is under the Government of the Prussian State. The Polytechnicum, or Technical High School, has been already described in NATURE, and is one of a number of technical universities situated in the several States which compose the German Empire. The Berlin Institute at Charlottenburg is by far the largest and the most completely equipped in Europe, and is already pronounced too small for the ever-increasing number of students, now exceeding 3000. In close proximity to this building in the Marsch Strasse, a turning in the leading avenue through the Thiergarten, the Physical-Technical Imperial Institute is now being erected. When complete it will consist of three detached buildings, in addition to separate residences for the Director and for some members of his staff. Two of these buildings are already finished, but the third is not yet erected, and pending its completion the work of this section of the Institute is carried on in a portion of the basement of the Royal Polytechnic.

The work of the Institute consists of two separate, but in some respects associated, sections. Section I. is devoted to pure scientific research, and Section II. to the testing and standardising of different kinds of measuring instruments. The Research Department is already housed in the main building of the new Institute, which has been planned especially for the purpose; whilst much of the testing work of the other department is still carried on in the Polytechnic building. The united Institute is under the general direction of Dr. Kohlrausch, and is maintained at an annual cost to the Government of about £15,000.

The Research Department of this interesting Institute is housed in a three-storeyed building, consisting of a basement, a main floor, and an upper storey. The construction is in many respects peculiar. The walls, instead of resting on separate concrete foundations, are built into a concrete flooring two metres deep, which covers the entire area of the building, so that the walls, basement, and flooring are closely bound together. The effect of this is that the building, if it vibrates at all, must vibrate as a whole, and no one part is separated from another. There is consequently no need for the isolated pillars which are found in some of our English laboratories. But even this arrangement does not appear to be perfect, and although the building is well set back from the road, in which there is some traffic, vibratory movements are not entirely avoided. The principal floor of the building consists of a central room, used mainly for experiments requiring constant temperature, surrounded by a corridor which leads into a number of other laboratories for experiments in electricity, magnetism, light, and heat. There are various interesting arrangements for maintaining the constant temperature of the central room, including the admission of light from the top through a series of separated glass roofs. The experimental work of the first section, or "Abtheilung," is under the direction of three heads of departments, Drs. Thiesen, Jaeger and Lummer, who occupy themselves respectively with investigations in heat, electricity, and light. They are aided by a number of permanent assistants, and by other workers who are admitted into the Institute for the prosecution of some special investigation. The members of the staff are engaged entirely in research, and have no teaching duties. The researches of the staff during the past year comprise numerous investigations connected with the determination of the expansion of bodies under heat; experiments with different kinds of thermometers, and pyrometers; electric and magnetic investigations; and photographic and photometric experiments. Short notices of these researches, giving the results as ascertained, are annually published.

Section I. is occupied exclusively with the testing of different measuring instruments. The makers of thermometers, manometers, and pressure gauges of all sorts, send their instruments to the Institute to be tested. Galvanic elements, accumulators, arc lights, ammeters, electric condensors, resistance coils, &c., are being tested in different parts of the building. No measurements connected with weight or mass are undertaken, and the testing of the strength of materials for builders and engineers is carried on in other buildings in no way connected with the Institute. The number of thermometers alone sent to the

Institute to be tested amounted last year to 11,656, of which 10,005 were clinical thermometers. A small charge is made for work done for the trade, but the receipts from this source of revenue do not exceed £1000. Incidentally, in connection with this work, there is a large amount of original investigation, and the staff employed are all men of proved scientific ability. New methods for obtaining more correct results and greater accuracy in measurement are constantly being investigated, and to this extent Section II. is equally with Section I. a laboratory of research. The experiments in Section II., however, are all directed towards the more accurate testing of instruments of precision. Some of the work done in this section is undertaken at the request of the staff of the Research Laboratory, and in connection with the experiments in pure science.

This Imperial Institute is under the immediate control of a Curatorium or Council, consisting of Professors of the University and Polytechnic, of engineering and technical experts, and of heads of industrial firms, presided over by a member of the Government. The selection of members of the staff, and permission to work at the Institute, rest with the Council. At first, applicants for admission were required to have obtained their Doctor's degree; but no such rule now holds. The ability to work, and the intention of prosecuting some original investigation previously approved by the Council, is a sufficient qualification. Each application for admission is considered on its merits. The Physical-Technical Imperial Institute is the crown of the series of coordinated Institutions which afford facilities for technical instruction in physical science, and opportunities for advanced research. In the city of Berlin are well represented the various educational agencies which have contributed so largely to the greatness of Germany; and the improvements which have been made of late years in the lighting and sanitation, in the postal and telephone arrangements of Berlin, are so many practical indications of the value of the education which the State and the city jointly provide. The Physical Institute is literally a temple dedicated to science, and its two divisions correspond with the twofold character of all scientific work—that which is undertaken with the sole object of widening the area of knowledge, and that which enables knowledge to be applied to the useful purposes of life. PHILIP MAGNUS.

THE PLANET JUPITER.

THIS bright planet now rises more than two hours and a half before midnight, and as his northern declination is about 18⅛°, he attains an altitude of about 57° when southing at about 5h. 15m. a.m. His apparent equatorial diameter this evening (Nov. 14) will be nearly 40″·5, and is increasing daily, so that by the end of the year it will be 45″·6, when the planet will be visible nearly all night, and remain above the horizon during a period of 15½ hours. He will arrive at opposition to the sun on January 24, 1896, and will then be displayed under the best conditions.

To those, however, who are disposed to study the complex and variable features exhibited by the belts, the present is an important time, for it is advisable that such markings should be watched during long periods, and that a large number of their transits should be recorded. Their individual rotation periods may then be ascertained, and the differences determined, together with the fluctuations of speed affecting the same objects. Details of this character can only be correctly derived when the observations are numerous and extend, at least, over a fairly long period of time. Materials of the kind alluded to, obtained in the early part of the opposition, are of special value for comparison with the observations made at the time of opposition, and with the terminal ones which may be secured in the evenings of June 1896, just before the planet leaves us for a season.

The features of Jupiter, though liable to certain changes, are yet, in some of their leading characteristics, remarkably durable. Like the spots on the sun, many of the markings on the planet disappear and reappear under very similar aspects. In fact, we are not without evidence that a certain degree of periodicity regulates the visibility of certain spots on the disc. In 1870 there was an eruption of dark spots along a belt in about 25° north latitude. In 1880 the phenomena appear to have recurred, for the same belt became studded with black spots, and in 1891 similar appearances were repeated. These markings are remarkable, as possibly indicating a periodical recurrence at intervals of about ten or eleven years. But it may be gravely doubted whether, in the present state of our knowledge, the materials exist for suitably investigating the question as to cyclical changes in the Jovian spots. The individuality of observers must affect the matter to a considerable degree, as their drawings and descriptions of the same features are seldom in agreement.

In recent years, the great red spot has not been so much observed as formerly. It has lost its striking character and its novelty, and planetary students have somewhat neglected it for newer objects more readily within reach. During the last ten years the mean rotation period of the spot has been 9h. 55m. 41s.; but it has shown some irregular variations. The slackening motion of the spot which operated so perceptibly between 1879 and 1885, and added seven seconds to the rotation period, appears to have been checked in the latter year, and the rate has been pretty evenly maintained since that time.

As to the visible aspect of the spot, it is now extremely faint, and can only be discerned on a good night of definition. Its feeble outlines are generally lost amid the very dark and well-marked boundaries of the belts in its immediate vicinity. But on a good night it is seen as a pinkish discolouration of the bright zone outlying the great southern equatorial belt, though its beautiful oval outline is distinguished with difficulty.

One of the interesting features of recent oppositions of Jupiter has been the series of dark and white spots plentifully arranged along the northern side of the great northern equatorial belt. These markings move swifter than the red spot, but not much so, for their period is 9h. 55m. 35s., or only six seconds less. They show changes, for sometimes one may be seen exceedingly dark, if not absolutely black, and just like a satellite-shadow in transit; but in a week or two a great decadence of tone may have affected it, and it appears scarcely darker than the belt on which it lies. These markings, so prominently fringing the northern belt, have certainly been visible during the last ten years. In 1885 I found their motion about eight seconds swifter than that of the red spot, but there were irregularities. Different spots, though in the same longitude and, probably, of the same character, do not yield coincident times of rotation, nor does any one object maintain exactly the same rate during a long period of time. The current in which they are situated, and by which they are transported to different longitudes, evidently suffers inequalities of speed, which are probably due to local disturbances underlying it.

These features of the northern belt are still very pronounced. On the morning of September 27, I observed two very dark spots projecting north from the belt and preceding the red spot at intervals of about four and two hours. The red spot follows Mr. Marth's zero meridian (System II.) by about seven minutes, but I have only obtained two observations since Jupiter has been visible as a morning star, and neither of these was very satisfactory.

During ensuing months it will be important to make as many drawings as possible, and to secure a large number of transits of the various markings. Among others the following may be specially mentioned:

(1) Light and dark spots near the equator (period 9h. 50m. 6s. in 1880, increased to 9h. 50m. 30s. in 1888).

(2) Dark spots on a belt in latitude 25° + (period 9h. 48m. in 1880, increased to about 9h. 49½m. in 1891).

(3) Dark spots and breaks in a very narrow belt in latitude 35° + (period 9h. 55m. 39s. in 1895).

(4) Light and dark spots in the region south of the red spot (period 9h. 55m. 18s., and apparently unchangeable between 1880 and 1891).

In the course of his work, the observer will also detect other features worthy of attention.

From eye-estimated transits the periods of the various objects can be very accurately ascertained, and Mr. Marth's valuable ephemerides for physical observations of Jupiter, published in *Monthly Notices* (June and supplementary numbers, 1895), will assist the student to reduce his own materials. W. F. DENNING.

NOTES.

THE Royal Society's medals have this year been adjudicated by the President and Council as follows:—The Copley Medal to Prof. Karl Weierstrass, For. Mem. R.S., for his investigations in pure mathematics; a Royal Medal to Prof. James Alfred Ewing, F.R.S., for his investigations on magnetic induction in iron and other metals; a Royal Medal to Dr. John Murray, for his services to biological science and oceanography in connection with the *Challenger* reports, and for his original contributions to the same; and the Davy Medal to Prof. William Ramsay, F.R.S., for his share in the discovery of argon, and for his discoveries regarding gaseous constituents of terrestrial minerals. Her Majesty the Queen has been graciously pleased to approve of the award of the Royal Medals. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's day (November 30). The Society will dine together at the Whitehall Rooms on the evening of the same day.

THE following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1896, at the anniversary meeting on November 30:—President: Sir Joseph Lister, Bart. Treasurer: Sir John Evans, K.C.B. Secretaries: Prof. Michael Foster, the Lord Rayleigh. Foreign Secretary: Dr. Edward Frankland. Other members of the Council: Mr. William Crookes, Sir Joseph Fayrer, K.C.S.I., Mr. Lazarus Fletcher, Dr. Walter Holbrook Gaskell, Dr. William Huggins, the Lord Kelvin, Prof. Alexander B. W. Kennedy, Prof. Horace Lamb, Prof. Edwin Ray Lankester, Prof. Charles Lapworth, Major Percy Alexander MacMahon, R.A., Prof. John Henry Poynting, Prof. Arthur William Rücker, Mr. Osbert Salvin, Prof. Harry Marshall Ward, Admiral William James Lloyd Wharton, C.B.

THE Trustees of the British Museum have decided not to fill up for the present the Keepership of Zoology, vacant by Dr. Günther's retirement, but to appoint two additional Assistant-Keepers from the existing staff, so that there will be one for each of the three sections into which the department will be divided for administration purposes, viz. insects, other invertebrates, and vertebrates. Sir William Flower will undertake the principal duties of Keeper of the Department, in addition to those of Director of the Natural History division of the Museum. A junior assistant will be appointed by competition, so as to keep up the numerical strength of the staff of the department. He will probably be attached to the entomological section, which although already the largest, still requires strengthening in order to cope with the arrangement of the vast number of specimens continually being added to the collection.

WE notice the announcement that, on November 20, Mr. Balfour will receive a deputation from the Association of Chambers of Commerce, in reference to the adoption of the metric system. Our readers will remember that this subject has been considered by a Select Committee of the House of Commons, which has recommended that the metric system of weights and measures be at once legalised for all purposes, and, after a lapse of two years, be rendered compulsory by Act of Parliament. The deputation will present to the First Lord of the Treasury memorials which have been prepared by the Association and by the Leeds and other Chambers of Commerce, urging the Government to bring in a Bill next Session for the purpose of carrying out these recommendations. We trust that the need for the reform of our present cumbersome system will be forcibly impressed upon the Government.

A STRONG American Committee is being formed to act with the Huxley Memorial Committee. *Science* states that substantially all the American scientific men who have been thought of as possibly willing to serve have, so far as approached, signified their willingness to do what they can in the matter. The biologists are likely to be well represented, particularly, and the leaders in scientific work in every field will do their full share. It is hoped and anticipated by our contemporary that the contributions from the United States will rival those of Great Britain, and exceed those of any other nation.

THE suggestion put forward by us, a fortnight ago, that the London County Council, or some other public body, should reciprocate the erection of a statue to Newton by the Paris Municipality, has not passed unnoticed in France. We indicated either Laplace or Lavoisier as a suitable subject for a statue in London; but the *Petit Journal*, in commending the idea, suggests that the right person to be honoured is Voltaire, who was an exile in England from 1726 to 1729, and who returned to France a great admirer of Newton. Voltaire was an enthusiastic exponent of Newtonian principles, and it was largely due to his support of them, in scientific and popular writings, that Descartes' vortex theory was rejected by the Paris Academy of Sciences.

The second International Congress of Applied Chemistry will be held in Paris next year. The Congress will be organised in ten sections, under the following heads: (1) Sugar and sugar-refinery; (2) Industries concerned with fermentation; (3) Agricultural industries; (4) Agricultural chemistry; (5) Official and commercial analyses of substances liable to duty; (6) Industrial chemistry; (7) Photography; (8) Metallurgy, mining, and explosives; (9) Biology, medical, pharmaceutical, and hygienic analysis; (10) Electro-chemistry. An International Exhibition of Chemical and Agricultural Industries will be held during the Congress, and for that purpose the Government has given the use of the whole of the Palais de l'Industrie.

A SIGN of advance in Africa comes to us in the shape of an announcement of the establishment of a monthly journal of South African science, arts, and crafts. The *Scientific African* (for that is the name of the new periodical) will contain popular scientific articles, written by experts, on South African animals, plants, rocks, and minerals, and giving information as to the habits, uses, and occurrences of organic and inorganic matter in South Africa and elsewhere. All the industries of South Africa, in the Colony, Transvaal, Free State, Rhodesia, &c., will be described, with photographic illustrations of the interiors of factories, the workings of mines and collieries, bridges,

harbour works, special processes in agriculture, and other industries by which the wealth and comfort of South Africa is being enhanced. It is intended to give the latest scientific news, and the columns of the paper will be open to the discussion of scientific matters. The *Scientific African* may thus do good service in collecting and publishing observations on the natural history of Africa, and we extend to it a hearty welcome.

THE death is announced of Dr. P. Bertkau, Professor of Zoology in the University of Bonn; and of Dr. Gustav Wilhelm, Professor of Agriculture in the Technische Hochschule of Gratz.

AT the commencement of this month, a Laboratoire d'Études et de Recherches, connected with the École de Physique et de Chemie industrelles, was opened at Paris. By paying a nominal monthly sum to the Paris Municipal Council, any one desiring to work in the laboratory will have placed at his disposal the materials required for his experiments. On the face of it, this seems an ideal means of furthering scientific research.

THE opening meeting of the new session of the Institution of Civil Engineers was held on Tuesday, in the new premises of the Institution, and Sir Benjamin Baker delivered his presidential address. The Emperor of Germany was elected an honorary member at the same meeting. This brings the number of honorary members up to twenty, out of a total membership of 6730.

A BRILLIANT display of aurora was observed in many parts of the British Islands on Saturday night, the 9th inst., following an exceptionally fine day during the recent unsettled and rainy period. But this temporary improvement was succeeded on Sunday by a barometrical disturbance of considerable intensity which reached our western coasts from the Atlantic, causing strong gales over the kingdom generally, and accompanied with heavy rainfall in the northern and western districts. The barometer fell as low as 28·05 inches in the Hebrides, and the changes of pressure generally were very considerable. The gale was characterised by heavy gusts, and these were at times very violent in the south and west; at Greenwich Observatory, a pressure of 19 lbs. on the square foot was recorded at midnight on the 10th.

THE Quarterly Summary of the *Weekly Weather Report* for July to September last, furnishes valuable means for the comparison of temperature, rainfall, &c., for the summer quarter of the last thirty years, in the principal wheat-producing and grazing districts of the British Islands. The tables show that the highest mean temperature for the three months was 61°·7 in the south of England, and the lowest 55°·4 in the north of Scotland; the mean excess over the whole of the country was 1°. During the last thirty years, the greatest mean excess was 2°·8 in the year 1868, and the greatest deficiency 2°·5 in 1888; there have only been four years with an excess of temperature since 1881. The mean rainfall for the whole of the British Islands during the quarter was 9·1 inches, being a deficiency of 0·3 inch on the average of thirty years. The average fall during this long period was largest in the west of Scotland, 11·8 inches, and lowest in the east of England, 7·5 inches.

THE third International Congress of Psychology will be held at Munich, August 4-7, 1896. The International Committee of Organisation is constituted as follows:—President, Prof. Dr. Stumpf; vice-president, Prof. Dr. Lipps; general secretary, Dr. Frhr. von Schrenck-Notzing; and twenty-five members, including, as representatives of British Psychology, Prof. Bain, Prof. Ferrier, Mr. F. W. H. Myers, Prof. Schäfer, Prof. Sidgwick, Prof. Sully, and Dr. Ward. The Congress will be opened on the morning of August 4, 1896, in the great "Aula" of the Royal University. All who desire to further the progress of psychology, and to foster personal relations among the students of psychology in different nations, are invited to take part in the meetings. The following is the provisional programme of work:—Section I. Psychophysiology. (*a*) Anatomy and Physiology of the brain and of the sense-organs (somatic basis of psychical life). Development of nerve-centres; theory of localisation and of neurons, paths of association and structure of the brain. Psychica functions of the central parts; reflexes, automatism, innervation, specific energies. (*b*) Psychophysics. Connection between physical and psychical processes; psychophysical methods; the law of Fechner. Physiology of the senses (muscular and cutaneous sensibility, audition, light-perception, audition colorée); psychical effects of certain agents (medicines). Reaction times. Measurement of vegetative reactions (inspiration, pulse, muscle-fatigue). Section II. Psychology of the normal individual. Scope, methods, and resources of Psychology. Observation and experiment: Psychology of sensations: Sensation and idea, memory and reproduction: Laws of association, fusion of ideas: Consciousness and unconsciousness, attention, habit, expectation, exercise: Perception of space (by sight, by touch, by the other senses); consciousness of depth-dimension, optical illusions. Perception of time. Theory of knowledge. Imagination. Theory of feeling. Feeling and sensation. Sensuous, æsthetic, ethical and logical feeling. Emotions. Laws of feeling: Theory of will. Feeling of willing and voluntary action. Expressive movements. Facts of ethics: Self-consciousness. Development of personality. Individual differences. Hypnotism, theory of suggestion, normal sleep, dreams: Psychical automatism: Suggestion in relation to pædagogics and criminality; pædagogical psychology. Section III. Psychopathology. Heredity in Psychopathology: Statistics: Can acquired qualities be transferred by inheritance? Psychical relations (somatic and psychic heredity), phenomena of degeneration, psychopathic inferiority (insane temperament): Genius and degeneration; moral and social importance of heredity Psychology in relation to criminality and jurisprudence. Functional nerve-disease (hysteria and epilepsy). Alternating consciousness; psychical infection; the pathological side of hypnotism; pathological states of sleep. Psychotherapy and suggestive treatment. Cognate phenomena; mental suggestion, telepathy, transposition of senses; international statistics of hallucinations. Hallucinations and illusions; imperative ideas, aphasia and similar pathological phenomena. Section IV. Comparative Psychology. Moral-statistics. The psychical life of the child. The psychical functions of animals. Ethnographical and anthropological psychology. Comparative psychology of languages; graphology. Forms of application may be obtained from the General Secretary, or from Prof. Sully, East Heath Road, Hampstead, N.W.

THE new quarterly number of the *Journal of the Royal Agricultural Society* (third series, No. 23) is largely occupied with reports of the Society's country meeting, held this year at Darlington. Among the novelties exhibited was a milking machine capable of milking ten cows simultaneously in about twelve minutes. The ingenious part of the apparatus appears to be the teat-cups, which are made of india-rubber of varying thickness, so as to reproduce as nearly as possible the kind of pressure exerted in the operation of hand-milking; a small steam-engine and a vacuum pump are the adjuncts. Papers of scientific interest include one by Prof. Brown, late Director of the Veterinary Department, on "Sheep-Scab in its Relation to Sheep Husbandry," in which the acari of scab are described and illustrated. Sir John Thorold explains the value, as food for calves, of the meat meal which is a by-product in the making of essence of beef. Mr. C. G. Roberts advocates the modification of threshing machines in such a way as to deal with the ears only, thereby avoiding the great waste of power which has been proved to occur when the entire straw is driven—and use-

lessly driven—through the machine. Dr. E. J. McWeeney contributes an illustrated paper on *Phoma Betæ* (Frank), a fungus that injures mangel. A lengthy paper on village water supplies deals with a subject of increasing importance in rural districts. In the statistical section of the journal it is stated that the wheat crop in Great Britain has this year suffered an unprecedented diminution to the extent of over half a million acres, or 26·5 per cent., and a table is given to show that the wheat area diminished in every county in England, without exception, the greatest decrease being one of 40,890 acres in Lincolnshire.

The papillary ridges on the hands and feet of monkeys and men form the subject of a paper received from Dr. D. Hepburn, and communicated by him to the Royal Dublin Society, from the *Transactions* of which (vol. v. series ii., 1895) it has been taken. Galton has shown that the great variety in the designs of the patterns among human finger-prints admit of classification under a small number of primary forms. It seemed probable, therefore, that among monkeys the primary forms of the patterns of human finger-prints might be found in conditions sufficiently simple to afford a key to the production of the more elaborate human patterns. With the idea of throwing light upon this point, Dr. Hepburn has prepared and examined a considerable number of impressions from the hands and feet of living Primates. In the chimpanzee and orang-utan, patterns were found similar to those commonly seen in man, whereas among lower monkeys the patterns approximated more closely to those found in the palm or sole. The conclusions arrived at are as follows: (1) The papillary ridges and their intervening furrows are adjuncts to the prehensile function and power of the hands and feet *as well as* arrangements associated with increased sensibility and discrimination of the sense of touch. (2) The eminences on which papillary ridges form designs or patterns are specially developed areas raised above the general level of surrounding parts. They are also special developments in relation to the prehensile function. This accounts for their constancy in the hands and feet of animals which have these organs modified for prehension. (3) The "design" which covers each of these eminences has its character determined by the position, shape, and dimensions of the particular eminence.

An improved calorimeter, for the application of the method of mixtures in determining specific heats, is described by Mr. F. A. Waterman in the current number of the *Philosophical Magazine*. Mr. Hesehus's ingenious suggestion is acted upon, to maintain the calorimeter, after the introduction of the heated body, at a constant temperature by means of cold water, instead of measuring the rise of temperature of the calorimeter. This arrangement gets rid of the radiation error, and eliminates the "water equivalent" of the vessel. By dropping the cold water in, stirring is also made unnecessary. The method has been placed by Mr. Waterman upon a footing of equality at least with other methods, but his success may be partly due to other improvements. The body experimented upon is heated by a coil of wire conveying a current, and surrounded by ice. The initial temperature of the body may thus be regulated by simply maintaining the current at a certain strength, and this temperature can be kept constant for five or six hours together to within 0°·1 C. The body is then plunged into a silver calorimeter surrounded by the bulb of a delicate air thermometer indicating a difference of temperature of 0°·01 C. The cold water is contained in a copper vessel having the shape of an inverted cone surrounded by ice. In this manner the ice cannot melt away and leave a free space round the vessel. The water-dropping arrangement and the electric heater are mounted on vertical axes in such a manner that they can be quickly swung into position just over the calorimeter. After the heated solid or liquid has been dropped in, the water-dropper is set to work, at first rapidly, and then slowly until the body has assumed the original temperature of the calorimeter. For bodies of the same weight and the same initial temperature, the specific heat is then simply measured by the amount of ice-cold water necessary to cool them to the temperature of the room.

A very useful summary of the results so far obtained by the new treatment of diphtheria with antitoxin has just been issued in pamphlet form by Dr. Welch, Professor of Pathology in the Johns Hopkins University, Baltimore. It is reprinted from the *Transactions* of the Association of American Physicians, and is an expansion of an address recently delivered by the author before the Association. Statistics have been carefully collected from all parts of the world, and the reduction in the case mortality for diphtheria by serum treatment is brought out in a very striking manner. Perhaps the best testimonial to the efficacy of the new treatment is furnished by the experience of Baginsky and others, who record the results obtained during an involuntary pause in the serum treatment caused by failure in the supply of serum. Thus Baginsky states that between March 1894 and March 1895, 525 children were treated with antitoxin with a fatality of 15·6 per cent. During the period when the supply of serum was exhausted, 126 children were treated without antitoxin with a fatality of 48·4 per cent. Similarly, Körte noted a rise in fatality from 33·1 per cent. during the serum period to 53·8 when no serum was procurable, and during an epidemic of diphtheria at Trieste the fatality rose from 18·7 per cent. to 50 per cent. when the supply of serum failed. The *Deutsche medicinische Wochenschrift* has instituted a collective investigation of all the cases of diphtheria treated with serum, and the second provisional report was published last August. Such statistics should prove of inestimable value in assisting the formation of a correct official judgment of the therapeutic value of the antitoxin; meanwhile, Dr. Welch states that "the study so far of the results of the treatment of over seven thousand cases of diphtheria by antitoxin demonstrates beyond all reasonable doubt that anti-diphtheritic serum is a specific curative agent for diphtheria surpassing in its efficacy all other known methods of treatment for this disease," whilst "the essential harmlessness of the serum has been demonstrated by over a hundred thousand injections."

The second part of the new ethnological journal, *Ethnoligsches Notizblatt*, has just appeared. Amongst other articles may be noted a short paper on two old carved canoe prows from New Zealand, by Dr. von Luschan, illustrated by a photographic plate. Prof. Grünwedel writes on representations of Gautama from Upper Birmah and other Indian notes. Dr. F. W. K. Müller describes a Japanese picture of the World-Mountain Meru. Some antique clay tablets from Guatemala are described and illustrated by Dr. E. Seler. Prof. W. Grube gives a list of the Chinese gods of the lower classes in Amoy. Some of the specimens collected by Count von Götzen, during his rapid journey across Africa, are described by Dr. Weule; the Count gave the whole of his valuable collection to the Berlin Museum. Under the title of "Anthropological Anniversary" in reference to the twenty-fifth anniversary of the Berlin Anthropological Society, Prof. Bastian gives an eminently characteristic review of anthropological research from his own point of view; he also has a notice on three quipus collected by Dr. Uhle: these are figured. The last half of the journal is occupied with notes and reviews of recent anthropological literature, most of which are signed, and to which Prof. Bastian largely contributes. While dealing with ethnographical matters in a way common to other similar journals, the editorial committee is evidently paying special attention to the philosophical aspects of anthropology, apparently under the guidance

of Prof. A. Bastian, and thus the journal will appeal to a wider circle of readers, and tend to advance ethnological studies.

VOL. III. No. 4 of *Contributions from the U.S. National Herbarium* consists of a "Flora of the Sand-hills of Nebraska," by Mr. P. A. Rydberg. The district consists almost entirely of sand-hills formed by the action of the wind, and still constantly altering their configuration from the same cause. The production of soil is only rendered possible by the holding together of the sand by the roots of grasses.

DR. GEORGE KING, F.R.S., Director of the Botanical Survey of India, has forwarded his report for the year 1894-95. Much work has been done during the year in the botanical survey of Northern India by Mr. J. F. Duthie. Mr. G. M. Woodrow has discovered that the tree from which the "date" matting so common in Poona is made, is *Phœnix robusta*, Hook. f.

WE have received, from Messrs. Baillière, Tindall, and Cox, a slender volume, in which is described the Tallerman-Sheffield Hot-Air Bath, with notes on its use in various hospitals. The invention is for the treatment of rheumatism, gout, rheumatic arthritis and similar complaints, by the local application of superheated dry air.

A PAMPHLET entitled "Clouds and Weather," written by Capt. D. Wilson-Barker, and illustrated from twenty-four photographs of clouds taken by him, has just been published at the office of the *Shipping World*. The pamphlet has been prepared for navigators, and is intended to show the interdependence of cloud and weather, so that "they who go down to the sea in ships" may know what relations between the two appear generally to hold good.

AMONG Mr. Murray's announcements of forthcoming works is one entitled "The Great Rift Valley: an Account of a Journey to Mount Kenya and Lake Baringo," by Dr. J. W. Gregory. It will contain a narrative of the journey, and chapters giving some account of the geology and ethnography of the eastern half of British East Africa, and notes on its flora and fauna. One chapter discusses "The Problems of the Distribution of the East African Flora and Fauna." The work will be illustrated by numerous maps and illustrations.

THE current number of the *Journal* of the Chemical Society contains an inset with reference to the Collective Index of the Transactions, Abstracts, and Proceedings, which the Society has determined to publish. The Index will be in two volumes, vol. i. extending from 1873 to 1882, and vol. ii. from 1883 to 1892. Both volumes will be sent to those who have been members of the Society since the end of 1882. Vol. ii. will be sent to Fellows who have joined the Society between January 1, 1883, and December 31, 1892. Fellows who are ineligible to receive gratis copies, and those who neglect to apply for them before the end of this year (or March 1, 1896, for Fellows resident abroad), may obtain them by purchase.

THE ninth edition of Müller-Pouillet's "Lehrbuch der Physik und Meteorologie," enlarged and revised by Dr. L. Pfaundler and Dr. Otto Lummer, is being published in parts by Herren Friedrich Vieweg und Sohn, Brunswick. We have previously announced the publication of several sections of this elaborate work (which, as a whole, makes three volumes, illustrated by no less than two thousand figures), and now notice the issue of the part of the second volume dealing with spectrum analysis, polarisation, double refraction, and the wave-theory of light. The complete second volume will take in both light and heat, but the optical section is itself divided into two parts, published separately, and it is the second of these parts that has just appeared. The treatment of the subject is full, and the value of the text is increased to the student by copious references to optical memoirs, papers, and reports.

WE have on our table several recently-published volumes referring to the proceedings of different learned societies, but limits of space prevent us from giving more than a passing mention of a few of the papers in them. In vol. xxviii. of the *Proceedings* of the Royal Society of New South Wales, Prof. Anderson Stuart's presidential address, and the communications to the Society in the latter half of last year, are printed. Among the papers we notice: "From Number to Quaternion," in which M. G. Fleuri shows how mathematicians may pass quite naturally from the idea of number to that of quaternion; an account of an aboriginal Bora held at Gundabloui in 1894, by Mr. R. H. Mathews; Mr. H. A. Hunt's essay on "Southerly Bursters," which gained the Abercromby prize of £25; the timbers of New South Wales, by Mr. J. V. de Coque; note on Australasian and other stone implements, by Prof. A. Liversidge; and an account of the distribution and collection of current-papers sent adrift to indicate the direction of the coastal currents around Australia, Tasmania, and New Zealand, by Mr. H. C. Russell. The volume contains forty-six plates illustrating the papers in it.

IN the *Mitteilungen* of the Berne Naturforschenden Gesellschaft for 1894 (Nos. 1335-1372), edited by Prof. J. H. Graf, Dr. J. G. Glur has a long paper on the fauna of lake-dwellings; Prof. G. Huber describes shooting-stars and meteorites, and the part these celestial bodies play in the universe, his paper being a good historical account of what is known about them; Dr. F. Stähli discusses the foci of cylinders; Dr. E. Baumberger gives a contribution to the geology of the Bieler Lake; and Dr. C. Wagner gives an analysis of Bessel's function of the first order. The volume containing these papers was received through Messrs. Williams and Norgate, who sent at the same time the *Compte rendu* of the seventy-seventh meeting of the Société Helvétique des Sciences Naturelles, held at Schaffhouse last year, and the *Verhandlungen* containing the reports of committees, and obituary notices of the late Dr. Rudolf Wolf, de Marignac (whose portrait forms a frontispiece), Louis de Coulon and B. Schenk.

THE November number of *Science Progress* contains several very good articles. Prof. W. Stirling contributes to it a detailed account of the life, personality, and work of the great physiologist and teacher, Carl Ludwig, and Dr. Sims Woodhead give a similar notice of Pasteur. Mr. F. H. Neville writes on the chemical nature of alloys and Dr. John Beddoe, F.R.S., on anthropometric research in India, his paper chiefly referring to the investigations made by Mr. H. H. Risley, with Governmental authority and support, into the anthropometry of the Bengal Presidency. One of the inferences which Mr. Risley drew from his investigation was that the castes in India are really ethnological, and not merely social divisions. Referring to a comparison of the size of head in the several provinces, Dr. Beddoe remarks: "Here the brachykephals surpass the dolichos, the Aryans the aborigines, the upper surpass the lower castes. But the Brahmans, despite their claims to be considered a kind of intellectual aristocracy, do not seem to surpass other high-caste men, unless it be in the dimensions of the forehead; and the Kaysaths, or writers, almost all of whom live by their brains and their pens, do not stand very much above the average. The differences are not inconsiderable; they exceed probably those which obtain between the superior and inferior classes in our own country; but I do not think they yield any evidence in support of the inheritance of acquired characters." Other papers in our contemporary are: "The Present State of Floral Biology," by Mr. J. C. Willis, and "Present Knowledge of the Mechanical Testing of Iron and Steel," by Prof. Hudson Beare.

THE additions to the Zoological Society's Gardens during the past week include a Western Slender-billed Cockatoo (*Licmetis pasinator*) from Western Australia, presented by Mrs. Halford Stephens; a Crossed Snake (*Psammophis crucifer*), a Hoary Snake (*Coronella cana*), two Ring-hals Snakes (*Sepedon hæmachtes*) from South Africa, presented by Mr. J. E. Matcham; a Common Wombat (*Phascolomys wombat*), a White-backed Piping Crow (*Gymnorhin leuconota*) from Australia, deposited; wo Pennant's Parrakeets (*Platycercus pennanti*) from Australia, purchased; a Rufous Rat Kangaroo (*Hypsiprymnus rufescens*), a Red Kangaroo (*Macropus rufus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE TEMPERATURE OF THE SUN.—Ebert's recent estimate of the solar temperature (NATURE, vol. lii. p. 232), based upon Langley's energy curves for heated solid bodies, is called in question by Dr. Paschen (*Astrophysical Journal*, vol. ii. p. 202). It appears that certain precautions have not been taken in formulating the law derived from experimental data, and that consequently the law does not hold even for the limits of temperature between which direct observations can be made. The chief defects of the former evaluations is that the prismatic energy curves have not been transformed into those for the normal spectrum; and when this is taken into account, the supposition that the wave-length of maximum energy is inversely proportional to the square root of the absolute temperature falls to the ground.

From a series of experiments made with the object of furthering theoretical investigations, Dr. Paschen considers it extremely probable that "the wave-length of the maximum of energy in the spectrum of an absolutely black body is inversely proportional to the absolute temperature." Assuming provisionally as the quantitative results of his observations, wave-length of max. energy × absolute temp. = 2700, and adopting Langley's value of $0\mu\cdot 5$ (μ = ·001 mm.) for the position of maximum energy in the normal solar spectrum, Dr. Paschen finds the solar temperature to be 5400° on the absolute scale, or 5130° C. This means that the sun gives an energy spectrum which is the same as that of an absolutely black body at 5130° C.; and this would be its temperature if its light were entirely a consequence of its heated condition, and if its surface possessed no selective reflection. Attention is drawn to the fact that as our experimental methods are improved, our estimates of the magnitude of the sun's temperature are reduced. Dr. Paschen's value is more than a thousand degrees lower than that of Messrs. Wilson and Gray.

THE DOUBLE STAR OΣ·285.—Dr. See, to whom we are indebted for the revision of the orbits of so many double stars, has lately given us another in the case of OΣ·285 (*Ast. Jour.* No. 356). We are almost tempted to ask whether any practical good results from the premature attempt to determine an orbit where insufficient observations exist, or where the chance errors of observations mask the apparent path of the star. Of course, one very practical value such inquiries may have, especially in the case of a close double star, is to point out the times when observations are likely to prove possible and effective. But the question arises, whether an elaborate interpolation formula or real elliptic elements are dealt with. We are the more concerned to put this question, because Dr. See himself points out that Mr. Gore has, from practically the same observations, given elements strikingly at variance with those to which he has been conducted. The more conspicuous differences between the two sets of elements are shown below.

	Gore (1845-1892).		See (1845-1895).
Period ...	118·57 years	...	76·67 years
Excentricity ...	0·58 ,,	...	0·470 ,,
Node ...	106°·58′ ,,	...	62°·2 ,,
Inclination ...	45·42 ,,	...	41·95 ,,

The difficulty of deciding which of the two orbits is the more probable representation of the motion is increased by the fact, that the position angle computed from both is very similar. Previous to 1865 and subsequent to 1887 (in the interval 1865–87, the observations were very uncertain, owing to the close approach of the components) the position angles computed from the two orbits for the same date are rarely separated by a degree, while occasionally the observations differ from the computed place by as much as ten degrees. Dr. See gives an ephemeris for the next five years, and if trustworthy observations can be made of stars separated by about 0″·3, additional light will be thrown on the motion of this interesting pair.

THE SPECTRUM OF α AQUILÆ.—The fact that the lines in the spectrum of α Aquilæ are much broader than the corresponding lines in the majority of stellar spectra, was first noticed by Prof. Pickering, who suggested that this appearance might be due to a very rapid rotation of the star. Photographs taken at Kensington and Potsdam have also shown this haziness of the lines.

The spectrum of this star has formed the subject of a somewhat extended research by M. Deslandres at the Paris Observatory, and by the use of a comparison spectrum enabling him to determine the velocity in the line of sight, he has obtained results of great interest (*Comptes rendus*, Nov. 4, p. 629). He finds that very frequently there are fine double bright lines running through the middle of the dark lines of hydrogen, and even sometimes through those of iron and calcium; the brightness of these lines varies with respect to the general intensity of the spectrum, and M. Deslandres attributes them to the chromosphere of the star.

Measurements of the radial velocity are given for fifty-six dates, and they clearly indicate periodic but complex variations. The maximum velocity of approach with respect to the sun was 38·4 km. per second on September 19, 1892, and of recession 11·4 km. per second on July 25, 1895. There appears to be a great oscillation with a maximum velocity every forty-three days, and superposed on this are one or more secondary oscillations, one of which has probably a period of about five days. M. Deslandres believes his results to indicate that Altaïr is at least a spectroscopic triple star; but he states that for a more complete knowledge of the phenomena, better apparatus and a less variable sky than that of Paris will be necessary.

β Ursæ Minoris also exhibits rapid fluctuations of velocity, and M. Deslandres' results in connection with this star will form the subject of a future paper.

VARIABILITY OF RED STARS.—In the current number of *Knowledge*, Dr. Brester gives a general account of his theory as to the cause of variability in red stars (see NATURE, vol. xxxix. p. 492), and extends it a step in order to account for the appearance of bright lines. It is assumed that the stars in question are cooling bodies, and that the atmospheres are sufficiently cooled down to permit the existence of chemical compounds. When some of the vapours are cooled to the dew point, they will condense in obscuring clouds, and produce a minimum without any reduction of temperature. In addition to saturated vapours, if we follow Dr. Brester, the atmospheres will also contain molecules of dissociated matter, which will only combine after the condensation of the saturated vapours has rendered the mixture sufficiently concentrated. The combination of the dissociated molecules produces heat enough to vapourise the clouds, and the maximum is restored by the opening to view of the constantly glowing interior. The presence of bright lines in the spectrum of a variable star near maximum is ascribed to "luminescence" produced by the chemical combination of the dissociated molecules. Thus, the bright lines at the maximum, according to Dr. Brester, are not the effect of heat, but rather of cooling. Dr. Brester finds some justification for this supposed origin of bright lines in the fact that carbon bisulphide gives a discontinuous spectrum at no higher a temperature than 150°; but it must be remembered that the bright lines in question are usually those of hydrogen, and there is no experimental demonstration that these lines can be produced except at a high temperature. To us it seems easier to regard the bright lines of hydrogen as being produced by true elevations of temperature about the time of maximum, such as are explained by the meteoritic hypothesis.

TYPHOID FEVER EPIDEMICS IN AMERICA.

THE factors which control the dissemination of disease are so numerous, and in many cases so complicated, that it is often only after long and patient searching that an epidemic is successfully tracked to the original nidus from which it has sprung.

By the careful record of data of this description, compiled with accuracy and care, we shall gradually become possessed of trustworthy material out of which an historical survey may be built up, and the task of deciphering the course and conduct of epidemic diseases materially lightened.

As a contribution to the history of typhoid fever epidemics, we warmly welcome the able report of some outbreaks of this disease in Massachusetts, made by, as well as under the direction of, Prof. W. T. Sedgwick.

The work before us was included, in the first instance, in the Twenty-fourth Annual Report of the State Board of Health of Massachusetts, but has been, and we think wisely, issued also as a separate pamphlet. No less than nine outbreaks of typhoid fever were investigated, but perhaps the most interesting and important is that which occurred in Lowell, one of the largest cities in the Merrimack Valley, and depending mainly for its water supply on the Merrimack River. Public attention was first called in December 1890 to the serious character of the epidemic of typhoid fever in the city, when it became known that in the preceding month 122 cases had been reported, and twenty-eight deaths from this disease had taken place. After a long and exhaustive investigation, the river water supply became suspected of being the vehicle of the specific infection to which the epidemic must be attributed. Prof. Sedgwick set to work, therefore, to find if there had been any special or unusual infection of the river *above* Lowell, and the discovery was made that an outbreak of typhoid fever, "such as had not been known for forty years," had occurred during the previous August, September, and October in a small village only three miles above Lowell, and situated on a small stream running into the Merrimack River. Four at least of the cases of typhoid fever were proved to have directly infected this small brook, which joins the river only two and a half miles above the intake of the Lowell Waterworks. Dr. Sedgwick states in his report that "the Merrimack River is regularly polluted above Lowell, not only by Stony Brook, but very extensively by the large cities of Nashua, Manchester, Concord, and Fitchburg, the sewers of all of which pour their raw contents directly into the Merrimack River or the Nashua. This they had been doing for months and years; and to the fact that Lowell has been willing to drink this regularly polluted water, *totally unpurified by filtration*, is chargeable the fact that typhoid fever has annually been excessive in that city. But the conditions were no worse than usual in these cities in September and October 1890. There was, however, as has been shown, an infection of a small and seemingly insignificant feeder of the Merrimack only two and a half miles above the intake of the Lowell Water Works, such as is not known to have occurred there for forty years." With respect to the chemical and bacterial examinations of the water, Dr. Sedgwick writes as follows:—

"These were made in the hope of discovering some unusual condition of the river, or of possibly detecting the Eberth bacillus itself. But, as usually happens in typhoid fever epidemics, the worst was over before the examinations began. The chemical examinations showed nothing that was not already known. The bacterial analyses revealed a noteworthy excess of *Bacillus coli communis*, confirming the chemical evidence of the presence of sewage in the city water as drawn from the river, but no Eberth bacilli were found."

We do not, however, attach perhaps the same importance as Dr. Sedgwick to the detection of the *B. coli communis* in the water, as we believe that this organism, or forms closely allied to it, may be found far more frequently present in pure peaty or other upland surface waters than is usually surmised, and that such microbial forms are not *necessarily* indicative of the access of sewage to a given water-supply.

The epidemic of typhoid fever, which apparently started above Lowell, infecting the Merrimack River, supplying that city with water, subsequently extended to Lawrence, situated on the same river, nine miles below Lowell, and a so using its waters for drinking purposes. In this connection Dr. Sedgwick remarks: "Inasmuch as there is good reason to believe that this unusual epidemic was caused by the unusual infection of the river at North Chelmsford and at Lowell, it is interesting to observe that some of the infectious material was apparently able to survive the comparatively unfavourable conditions imposed by the long and slow passage through the Lawrence reservoir and the service pipes." [The "unfavourable conditions" here referred to are the processes of sedimentation to which the microbial contents of the water would be exposed under these circumstances.] "It would seem therefore that, while much of it must have perished *en route*, some of it did not; and, as the time of year was November and December, we are safe in concluding that during these months, under certain conditions, some of the infectious material of typhoid fever may be conveyed nine miles by a river, may slowly travel through a distributing reservoir, and still remain effective to a very dangerous extent if swallowed in drinking water." During the four years preceding 1891, the average mortality from typhoid fever in Lowell is stated to have been 8·44 per 10,000, whilst in 1890-91 it rose to 19·54 per 10,000. Thus the average death-rate from typhoid fever is considerably higher than we experience in London, but it sinks into comparative insignificance when we contrast it with the statistics of typhoid fever in Chicago compiled by Dr. O. M. Huff, of that city. In 1891 the deaths directly attributed to typhoid fever in Chicago amounted to no less than 16·64 per 10,000. In 1892 the condition of things was somewhat improved, although the death-rate, says Dr. Huff, still remained three times as great as in New York, five times as great as in London, and more than six times the rate of Berlin. Dr. Huff has made a minute study of the relation of typhoid fever to the water supply of Chicago, and has come to the conclusion that the contamination of the drinking water supplied to the city with sewage is the "efficient cause" of this alarming mortality. It is stated that Lake Michigan "serves both as a water-bucket and a cesspool for Chicago." An American scientific journal, in reviewing this report, reasonably suggests that every resident of Chicago ought to be advised of the fact that there is death in the water-pipe.

It is to be hoped that the attention now being bestowed in America on subjects both directly and indirectly connected with public health will lead to beneficial practical results, and that the distribution of water openly contaminated with sewage in its raw, unfiltered condition for drinking purposes, will be summarily prohibited by law in all countries before such grave consequences have again to be met as attended the distribution in Hamburg of raw, unfiltered river Elbe water for dietetic purposes. G. C. Frankland.

AN ACCOUNT OF THE CONSTRUCTION AND STANDARDISATION OF APPARATUS, RECENTLY ACQUIRED BY KEW OBSERVATORY, FOR THE MEASUREMENT OF TEMPERATURE.

The accuracy of the measurements made at Kew Observatory may, without exaggeration, be regarded as a matter of national concern. It is right, therefore, that the scientific public should be made acquainted with the principles involved and the methods of comparison employed in any series of measurements conducted at the Observatory; more especially when a new departure is made, either in the apparatus used or in the nature of the observations.

In the absence from England of Prof. Callendar, F.R.S., the writer, at the request of the Kew Committee, undertook the responsibilities connected with the preparation and standardisation of the apparatus, recently installed at Kew, for the accurate measurement of temperatures—particularly of high temperatures.

It would be impossible, without unduly trespassing upon these pages, to give a full description of the principles on which the measurements of temperatures by platinum thermometers are founded, or of the methods of standardisation adopted. I will, however, endeavour to briefly indicate reasons for our faith in the principles involved and the accuracy of the methods employed.

I make this communication with the (unofficial) consent of the Kew Sub-Committee, to whom the oversight of this matter was delegated; at the same time it should be understood that the writer alone is responsible for the statements, or opinions, advanced in the following pages.

Sir Douglas Galton in his address at Ipswich remarked that "British students of science are compelled to resort to Berlin or Paris when they require to compare their more delicate instruments and apparatus with recognised standards." We may now hope, however, that, at all events as regards temperature measurements, his statement will ere long require modification.

I. *Brief Explanation of the Terminology and of the Principles involved in the Measurements of Temperature by Platinum Thermometers.*

A platinum temperature scale is one so constructed that a rise of one degree on that scale at any temperature would cause the electrical resistance of a platinum wire to increase by one-

hundredth of the difference between its resistance at 100° and 0° C.

Hence, if R be the resistance at any temperature, R_1 the resistance at 100° C., R_0 at 0° C., and *pt* the temperature on the platinum scale, then

$$pt = \frac{R - R_0}{R_1 - R_0} \times 100.$$

The investigations of Prof. Callendar[1] established the relation between *pt* and *t* (where *t* is the temperature on the air scale) over the range 0° to about 600° C. for a particular sample of platinum wire.

This relation is given by the following equation.

$$d = t - pt = \delta\left\{\left(\frac{t}{100}\right)^2 - \frac{t}{100}\right\}. \quad . \quad . \quad . \text{ Eq. } (d)$$

the value of δ for Callendar's wire being 1·57.

If it was at all times possible to obtain platinum wires of *exactly* the same degree of purity as Callendar's, we could at once establish a standard platinum scale, which could be used for purposes of reference independently of any assumptions as to its relation to the air scale. The impossibility of securing uniformity in this respect, however, would, at first sight, appear to be an insuperable impediment to the adoption of such a proposal.

Subsequent experiments by Callendar and myself led, however, to the following conclusion.[2]

That, although the value of δ varies greatly according to the purity of the sample of platinum, the relation given by the equation (*d*) holds true, provided the percentage of impurities is small (this condition is sufficiently fulfilled by ordinary commercial samples).

This conclusion is an exceedingly important one, for (the $t - pt$ curve in every case being a parabola) it is only necessary to determine the resistance at three different temperatures in order to ascertain the appropriate value of δ, and thus to completely standardise the thermometer.

Much experimental work had to be accomplished before we could venture to regard the above proposition as established; but I think that any impartial reader, who cares to study the original papers[3] dealing with this matter, will admit that the evidence is sufficient.

The three temperatures selected for the purposes of standardisation were the melting-point of ice, steam at a pressure of 760 m.m., and the vapour of sulphur at the same pressure.

Certain discrepancies between thermometers thus standardised and others standardised by direct comparison with the air thermometer, led to a redetermination (by means of an air thermometer) of the boiling-point of sulphur, when we found that Regnault's value (448°·34) was too high, our experiments leading to the conclusion that 444°·53 was the correct value.[4]

Subsequent investigations by different observers have confirmed the accuracy of the above conclusions, which may now be regarded as experimentally established over the range 0° to 600° C.

There is, however, a large amount of indirect evidence which indicates that formula (*d*) holds true over a far more extended range.

For example, the results obtained by Messrs. Heycock and Neville (*Chem. Soc. Trans.*, 1895) are entirely dependent on the validity of the above conclusions. They find the freezing-point of copper as 1080°·5 C., whereas Holborn and Wien, using a platinum rhodium couple standardised by direct comparison with the porcelain air thermometer, find 1082° as the value of the same constant.[1]

As illustrating the identity of the results obtained by the use of thermometers having a very different value of δ, I quote the following numbers from Table XII. of Heycock and Neville's paper:—

Pyrometer.	Value of δ.	Freezing-point of gold. °
13	1·500	1061·9
15	2·040	1061·2
18	1·574	1061·4
13A	1·553	1061·9
14	1·511	1062·0

Results of this kind prove that even if the reduction does not express the temperature accurately in the air scale, it at all events gives us a *constant* scale in which all high temperatures can be expressed, and it is further evident that this constant scale differs but little (even at these high temperatures) from the true air scale.[2]

Indications are not wanting that the same relations hold true at very low temperatures.[3]

Finally, a very careful comparison of the platinum and air thermometers over the range 0° to 100° C., and also of the platinum thermometer with the nitrogen standard of the Bureau International, establishes the validity of the methods of observation and reduction at ordinary temperatures.

As regards the constancy of platinum thermometers there should now be little uncertainty. The prevailing doubt (amongst those who have not used them) may be traced to the adverse report of a British Association Committee in 1874, on another form of the instrument, and I would refer those who may be influenced by that report to a letter by Prof. Carey Foster, F.R.S., in NATURE, August 23, 1894.

An inspection of the voluminous tables given in Heycock and Neville's paper (*supra*) will show, however, that when the thermometers are repeatedly exposed to temperatures above 900° or so, a slight permanent increase in FI (the Fundamental Interval = $R_1 - R_0$) is observable. It is probable that this change is due to a permanent thickening of the mica plates by which the wire is supported, and thus, on cooling, the wire is slightly strained. The change is small, and can always be traced by repeating the determinations of R_1 and R_0, and does not appear to appreciably affect the values of δ.

To show the order of magnitude of the change, I give the following illustration, compiled from Table VIII. of Heycock and Neville's paper.

History of Pyrometer 13.

On August 3, 1894, the fundamental interval was 100·64. During the next few months this pyrometer was used for the determination of the freezing-points of the following substances:—

Substance.	Number of determinations.
Silver	10
Aluminium	12
Potassium sulphate	5
Sodium sulphate	4
Sodium carbonate	3
Magnesium	5
Antimony	2
Tin	3
B.P. of sulphur	6

Also the pyrometer had been raised to a bright red heat in a muffle furnace some scores of times, and the exterior porcelain

1 *Phil. Trans. Roy. Soc.* A, 1887.

2 A summary of these experiments is given in *Science Progress*, September 1894.

3 Callendar, *Phil. Trans. Roy. Soc.* A, 1887; Griffiths, "Report of Electrical Standards Committee, B.A. 1890; Heycock and Neville, *Chem. Soc. Journ.* 1890; Griffiths, *Phil. Trans. Roy. Soc.* A, 1891; Callendar and Griffiths, *Phil. Trans. Roy. Soc.* A, 1891; Callendar, *Phil. Mag.*, July 1891; Griffiths and Clark, *Phil. Mag.*, December 1892; Griffiths, *Phil. Trans. Roy. Soc.* A, 1893; *ibid.*, *Proc. Roy. Soc.* vol. lv. 1894; *ibid.*, *Science Progress*, 1894; Thorpe, "Dictionary of Applied Chemistry," article "Thermometry"; Heycock and Neville, *Trans. Chem. Soc.* 1895.

4 In the last edition of Watts's "Dictionary of Chemistry," article "Sulphur," I find that some doubts are expressed (by Mr Pattison Muir) as to the validity of this determination, owing to uncertainty as to the purity of our sample of sulphur. I sub-equently investigated the boiling-point of a specially pure sample by means of one of the platinum thermometers (thermometer E) used during the original comparison of the air and platinum thermometers in sulphur vapour, and I found no evidence of any difference in the boiling-point of the two samples. We may assume, therefore, that if any impurities were present, they were not of such a nature as to influence the temperature of the vapour.

1 The following example illustrates the importance of the alteration in the boiling-point of sulphur. In Table VI. of Heycock and Neville's paper (*supra*) are given the details of an observation on the freezing-point of Cu determined by pyrometer No. 8. They are as follows: $pt_s = 421·29$, $\delta = 1·517$, $d = 159·3$, $t = 1080·7$. If we assumed the validity of Regnault's boiling-point of sulphur (448°·34), the above value of pt_s would change the value of δ to 1·729; this would give $d = 181·6$; hence $t = 1103°·0$. In this case the discrepancy between the results of Holborn and Wien, and Heycock and Neville would be very marked—a difference of 21°·0 as against the present difference of 1°·3.

2 Messrs. Heycock and Neville, in Table XVI. (*Chem. Soc. Trans.*, 1895, p. 195), give Violle's value for the freezing-point of gold as 1035° C., and the discrepancy between this number and that found by them (1061°·7) is consid rable. A redetermination, however, by Violle in 1892 (*Comptes rendus*, 92, p. 866) raised his number to 1045°. Some recent experiments by Le Chatelier (*Comptes rendus*, August 12, 1895) lead that observer to the conclusion that Violle's later value should be further raised by about 15° (or at all events by a number "not exceeding 20°"), *i.e.* to about 1060° C., a very close approximation to the 1061°·7 found by Heycock and Neville in December 1894.

3 Griffiths and Clark, *Phil. Mag.*, December 1892.

tube had on three occasions been removed and replaced by a new one.

At the close of these operations (December 19, 1894) the value of FI had risen to 101·003, an increase of 0·36 per cent.

It should be remembered that in each determination the substances were raised to 50° or 100° above their freezing-points before the observations were taken; for example, the freezing-point of potassium sulphate is given as 1066° C., but it is certain that when determining this point the pyrometer was previously raised to a temperature considerably exceeding 1100°. A study of the original table will show that the rate of increase in FI diminishes with use.

As this question of constancy is of vital importance, Messrs. Heycock and Neville have given me permission to state that they have used only one pyrometer during a continuous series of high-temperature determinations extending over two months of the past summer. When the account of their work is published, it will be found that although the number of the observations on the freezing-points of alloys exceeds some hundreds, the pyrometer is as efficient now as at the commencement of their work. Its FI on July 28 was 100·148, on August 20, 100·357, and on nearly all the intervening days it had been immersed in molten metal at temperatures between 900° and 1000° for five or six hours at a time. A determination of the freezing-point of copper, made at the close of the above series of experiments, gave a value practically identical with that previously published.

Apart from the slight change in FI, above illustrated, there is abundant evidence that when *completely protected from the action of furnace gases* the platinum wire undergoes no change. Space does not permit the accumulation of further evidence, but full information will be found in the papers already referred to.

II. *Description of the Apparatus.*

The facts dwelt upon in Section I. show that if the methods of platinum thermometry are adopted, the measurement of temperature becomes a question of the measurement of electrical resistance, and there are few physical quantities which can, if due precautions are taken, be measured with greater accuracy than the resistance of a conductor. The Kew apparatus, therefore, may be regarded as designed for the accurate measurement of the resistance of a platinum wire, and some of the contrivances introduced with the object of securing greater accuracy are, I believe, peculiar to this apparatus.

The designs were drawn up by Prof. Callendar and myself, after consultation with Mr. Horace Darwin, and the apparatus was constructed by the Cambridge Scientific Instrument Company, Ltd., under the personal direction of Mr. Pye.

Fig. 1 is a diagrammatic view of the connections.

The coils S_1 and S_2 are of equal resistance (about 5 ohms), Q is a set of resistance coils, A B a bridge-wire, and K a thermo-electric key. When the resistances between C_1 and C_2 and P_1 and P_2 are equal, the bridge is balanced if the resistance at Q is zero, and the contact-maker H is at the mark O near the centre of the bridge-wire. The scale of this wire is so graduated that if the reading to right or left of O be added or subtracted from r (the resistance at Q), the result gives the value of P – C where P is the resistance between P_1 and P_2, and C the resistance between C_1 and C_2.

Now $P = p + C_p$, where p is the platinum coil resistance, and C_p the resistance of the leads to that coil, including the thick platinum wires which run down the thermometer stem. An equal pair of leads run from C_1 C_2 to similar thick platinum wires in the thermometer stem, which are connected together at the lower extremities, but have no contact with the coil.

Thus $r \pm OH = p + C_p - C$; and therefore if $C_p = C$, we get $p = r \pm OH$.

The leads C_p and C are everywhere bound together except in the thermometer stem, where they are parallel and adjacent, being held in position by their mica discs, hence changes in C_p and C caused by changes in temperature do not affect the resulting value of p, and thus the readings are independent of the thermometer stem-temperature—a matter of great importance at high temperatures.[1]

A certain amount of stem immersion is, however, necessary, for the lower extremities of the leads must be heated to the bulb temperature, otherwise they would, by conduction, cool the extremities of the coil; this is an additional reason for forming the leads of platinum, which has a low thermal conductivity.

A preliminary series of experiments led to the conclusion that a certain quality of white marble had superior insulating properties to ebonite—the material generally used for the tops of resistance-boxes. This superiority was partially due to its non-hygroscopic properties; for example, I placed slabs of the best ebonite, black marble, and this white marble in an ice-safe for some time. I then removed them one by one to the warm laboratory, and tested them under similar conditions with a "pressure" of 100 volts. The insulating powers of the ebonite and black marble fell off alarmingly, while the white marble was but little affected.

Some difficulty was experienced by the makers in devising a satisfactory method of attachment between the marble and the many brass connections, &c., but this difficulty was at length overcome. The coil and bridge-wire were constructed from one sample of platinum silver. The coil of a platinum thermometer was replaced by a specimen of the wire (diameter ·008 in.) from which the coils were formed, and which had been subjected to the same process of annealing. Its temperature coefficient was then determined with great care over the range 15° to 25° C. (nitrogen scale), and was found to be ·000260 in terms of the

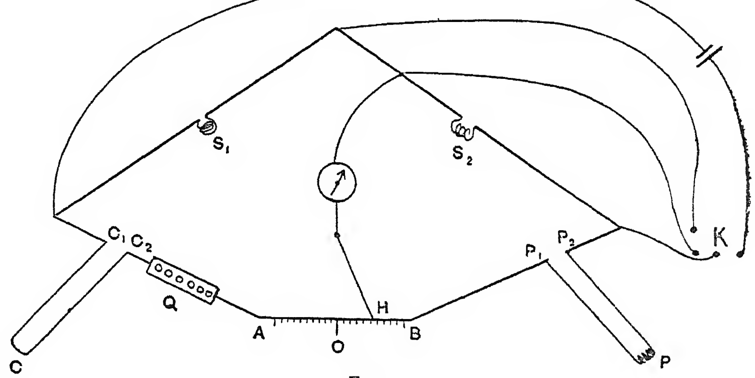

FIG. 1.

resistance at 20° C. I proposed to keep the box when in use at a temperature near 20° C., for it is wise, when feasible, to maintain all measuring instruments at a temperature exceeding that of an ordinary room, for two reasons: (1) it is generally easy to raise the temperature of the apparatus above that of the air, whereas it is extremely difficult to keep it at a lower temperature; (2) when the temperature of the apparatus exceeds that of the room, all its surfaces are kept dry, and also more dust-free than would otherwise be the case.

The greatest difficulty encountered in resistance measurements is (according to my experience) uncertainty as to the actual temperature of the coils. If a resistance-box is placed in a tank, it is true that five sides of it can be maintained at a constant temperature, but the top is necessarily exposed; and since all the coils are ultimately connected with the top, their temperature at times differs considerably from that of the tank.

[1] The *absolute* equality of C and Cp is not essential; both are small as compared with p $\left(\frac{c}{p}\text{ is always less than }\frac{1}{50}\right)$, thus $Cp - C$ is a very small fraction of p, and it is only the temperature change in $Cp - C$ that affects the measurements. The total resistance of the thick copper leads from the box to the thermometer is so small, and they are subject to such comparatively slight changes of temperature, that the temperature change of their difference may almost certainly be neglected. The greater part of Cp and C is the resistance of the platinum stem leads, which are certainly exposed to considerable temperature changes. If, however, they are made of the same platinum as the coil, then any irregularity has nearly the same effect as an alteration in the original length of the coil, and does not appreciably affect the ratio $\frac{R_1}{R_0}$ or the values of pt. In all carefully constructed thermometers the value of $Cp - C$ may be regarded as zero.

Again, the thick coating of paraffin, and the solid core, which are almost universally prevalent, increase the uncertainty, for if any temperature change is taking place the lag is considerable.

These sources of error were diminished as follows: the sides and bottom of the box are the inner walls of a double copper tank, holding about eight gallons of water maintained at a temperature near 20° C. by a regulator. Over the top of the box and tank is fixed a case similar to that of an ordinary balance, the front glass of which is only raised when adjustment of plugs and contact-maker is necessary, all connecting screws being exterior to the case. The silk-covered coils (which are double in all cases to reduce the effects of current heating) are suspended from an ebonite rack within the box. They received

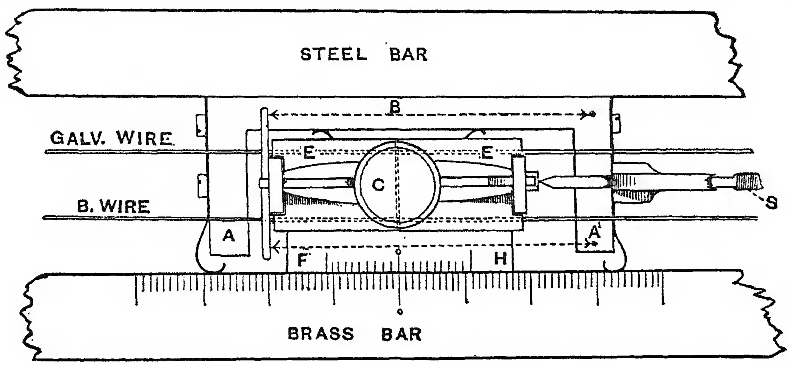

FIG. 2.

the thinnest possible coating of paraffin and are wound loosely and openly, so as to be subjected to no strain, and also to permit free circulation of air to all parts of the wires. An open scale mercury thermometer, with a small bulb, is placed with its bulb contiguous to one of the higher resistance coils. A series of observations leads to the conclusion that, under these circumstances, the thermometer-reading sufficiently indicates the real temperature of the coils, provided of course that no rapid changes are taking place, and this conclusion is borne out by the observations of Messrs. Heycock and Neville on a box similarly protected by a balance case.

The coils were annealed in paraffin at a temperature slightly below that which would carbonise the silk covering.

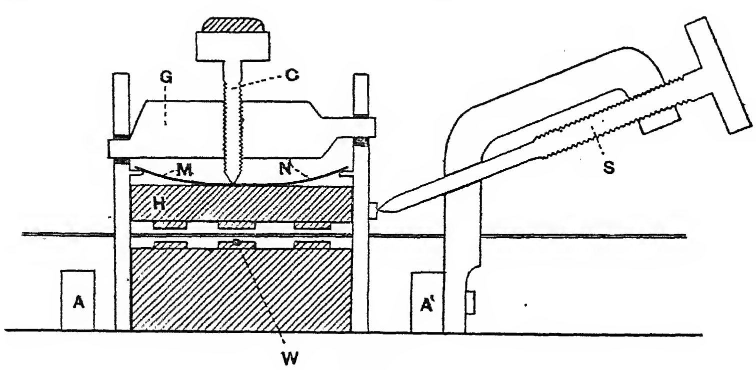

FIG. 3.

The box-unit is (approximately) $\frac{1}{100}$th of a Board of Trade ohm. The coils have the following nominal values in terms of this unit.

A	B	C	D	E	F	G	H	FI
640,	320,	160,	80,	40,	20,	10,	5,	100,

and the bridge-wire has such a section that a change of 1 c.m. in the reading indicates (approximately) a change of 1 unit in *p* (in reality 1 c.m. = ·9957 box units), and the resistance of the thermometers, with one exception, is such that a change of one box unit corresponds to 1° on the platinum scale.

The whole length of the bridge-wire is 30 c.m.; thus any resistance exceeding 40 units can be measured in three or four different ways by changing plugs and bridge-wire contact. Thus the accuracy of the various corrections can at any time be exposed to a severe test.

Great attention was given to the drawing of the bridge-wire, for, although the effect of irregularities would be eliminated by the subsequent calibration, it was desirable to make it as uniform as possible. In this matter the Scientific Instrument Company were very successful, for it was ultimately ascertained that if the wire was assumed as uniform, the greatest resulting error would not exceed 0·005 units.

Before its final attachment to the box, the wire was hung from a conductor, and had a small weight fastened to the lower end, which communicated with a cup of mercury; it was then raised to a bright red heat by means of an electric current, after which the cells were gradually switched off, so that the cooling was slow. The annealing was thus very perfect, and the wire on being released remained quite straight. The coefficient of expansion of this platinum-silver alloy lies between that of steel and brass. A narrow parallelogram was formed, whose longer sides consisted of brass and steel bars respectively—the shorter sides of ebonite. The steel and iron bars were connected at their centres to the marble box top, and the wire placed between, and parallel to, them, its ends being fixed to the ebonite cross-pieces and connected by flexible brass strips to the remainder of the bridge. By this arrangement the tension of the bridge-wire is kept constant when the temperature of the box alters, and, at the same time, the zero-point at the centre remains unchanged in position.

A second platinum-silver wire, permanently connected with the galvanometer, lies alongside the true bridge-wire. The vernier-slide carries a small cross-bar of the same wire placed beneath and at right angles to the bridge and galvanometer wires, and only just clearing them (Fig. 3). When the contact-screw is either forced, or screwed down, both wires are pressed on to the cross-piece by means of pads, and arrangements are made to prevent any pressure being exerted which could injure the bridge-wire. This method has several advantages, one of which is that only similar metals are brought in contact, and thus thermo-electric effects at this junction are avoided.

The vernier reads directly (by means of a microscope) to $\frac{1}{50}$th m.m., thus $\frac{1}{100}$th m.m. can be estimated; *i.e.* approximately 0·001 box units, or 0·00001 ohms.

Great difficulty has hitherto been experienced in constructing a fine adjustment for a bridge-wire contact. It must be of such a nature that it will permit the free movement by hand of the contact-maker to any position. Again, if, owing to an oversight the contact-maker is screwed down, and any of the ordinary means of fine adjustment are used, the bridge-wire is subjected to a scraping action which may affect its section. These difficulties have been overcome by an ingenious device designed for this apparatus by Mr. Horace Darwin.

Fig. 2 is a plan, and Fig. 3 a vertical section of the contact-maker.

A B A' (Fig. 2) is a brass framework which slides between the steel and brass bars previously referred to. An inner block F E E' H stands within the brass framework with a play-space at its ends of about 1 c.m. Springs at A and A' press the brass frame against the steel bar, and springs at E, E' press the inner block against the front brass bar. Thus the pressure of the brass frame against the steel bar is the sum of the pressures of the springs at A, A', E and E', whereas the pressure of the inner block on the front bar at F H is the sum of E and E' only; if, therefore, the screw S is rotated the inner block alone is moved. As the screw S recedes the inner block is made to follow it by means of long springs indicated in the plan by the dotted lines with arrow-heads. If by inadvertence S is turned when the bridge-wire has not been released by the screw C

(Fig. 3), then the outer framework A B A′ moves instead of the inner block.

The arrangement by which the pads in the block H can be either pressed down for temporary, or screwed down for more permanent, observations is shown by the section in Fig. 3. The spring M N lifts the pads off the bridge and galvanometer wires, which therefore do not touch the cross-wire (whose section is shown at W) unless a downward pressure is exerted on the block H.

By holding the head of the screw S the whole contact-maker can be pushed to any desired position.

The vernier is shown at F H (Fig. 2).

The box contains coils of 20 and 100 ohms, which can be thrown into the battery circuit by means of a switch, and also a galvanometer shunt of about $\frac{1}{10}$ the galvanometer resistance.

With the exception of the points to which I have drawn attention, the resistance-box resembles those ordinarily in use.

The galvanometer has a resistance about 5 ohms, and is sensitive and "dead-beat." A fixed scale is placed before the mirror, and the image viewed through a microscope. Very small deflections can thus be observed, and observations can be taken in bright daylight.

This last has a coil whose resistance is 2·5 times as great as he preceding ones.

All these thermometers have been annealed at a temperature of about 1000° C., Nos. 5 and 6 being temporarily placed in porcelain tubes for that purpose.

The apparatus for the standardisation in ice, steam, and sulphur-vapour presents certain distinctive features, most of which, however, are described in *Phil. Trans. Roy. Soc.*, vol. 182 A.

Messrs. Heycock and Neville were so kind as to undertake the design and arrangement of the furnaces, &c., for the high temperature work, which are, in the main, similar to those used during this summer for the purposes of their investigations into the behaviour of alloys. As an account of their work will shortly be published, I shall not venture to anticipate it by any description. Arrangements have been made for (1) the standardisation of thermometers by observations on the freezing-point of silver when placed in a reducing atmosphere;[1] (2) the comparison of the Kew standards with other thermometers over the range 100° to 300° C. by means of a well-stirred bath of a fusible metal covered with paraffin or oil; (3) the comparison over a range 300° to 1200° C. in a bath of melted tin placed in a reducing atmosphere.

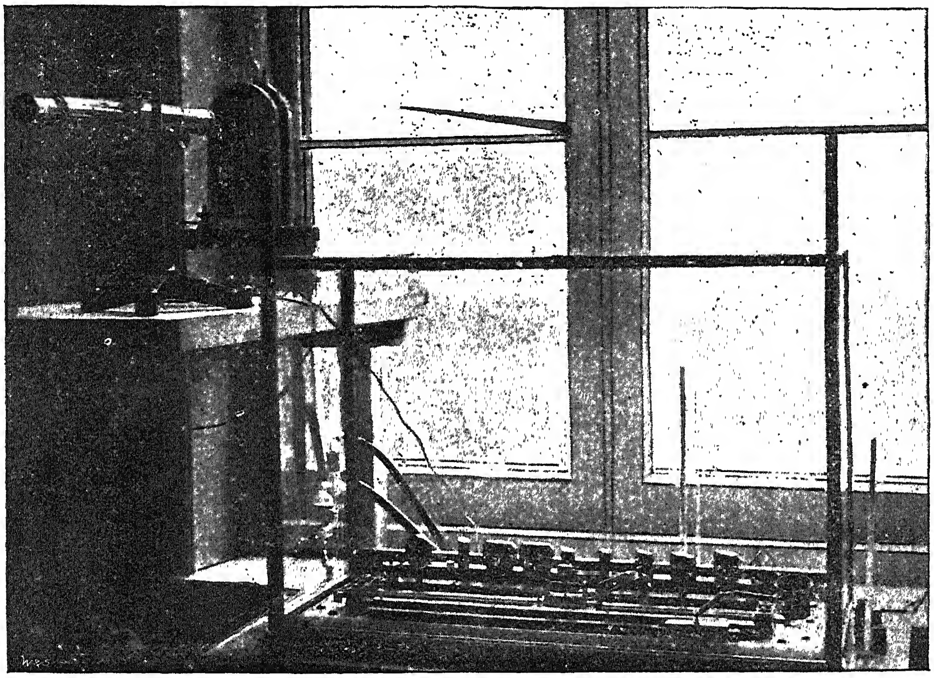

FIG. 4.

Thermo-electric effects (which at high temperatures are occasionally considerable) are eliminated by the use of a special key described in *Phil. Trans. Roy. Soc.*, vol. 184 A, p. 397.

The leads from the box to the thermometer are about five yards in length, and are each composed of 136 strands of copper wire carefully insulated. The thermometers can thus be used in any part of the room.

Six thermometers have been supplied, all of whose coils are formed from the same sample of specially pure platinum wire—diameter 0·006 inches. The length of wire in Nos. 1 to 5 is about 18 inches, the mica framework which supports the coil is from 1¼ to 1½ inches in length, and this portion is termed the bulb.

Nos. 1 and 2 are contained in porcelain tubes 1·2 c.m. in diameter, 40 c.m. long.

Nos. 3 and 4 are contained in porcelain tubes 1·5 c.m. in diameter, 36 c.m. long.

No. 5 is contained in a glass tube 1·4 c.m. in diameter, 40 c.m. long.

No. 6 is contained in a glass tube 1·7 c.m. in diameter, 40 c.m. long.

The whole of the apparatus is placed in a special building erected for this purpose by the Kew Committee, according to designs by Mr. W. N. Shaw, F.R.S., and myself, after consultation with Messrs. Heycock and Neville. The building is found to admirably fulfil its purpose, the only drawback being the defective gas supply, which will, however, shortly be remedied by the insertion of a larger main between the Observatory and the outbuildings.

Fig. 4 (a copy of a photograph by Mr. Hugo) gives the relative positions of box and galvanometer. It will be seen that the observer can manipulate the contact-maker without removing his eye from the galvanometer-microscope, a great advantage when observing small temperature changes. Immediately to the right of the resistance box, but exterior to the limits of this plate, is a large draught-chamber containing the furnaces, &c.

III. *The Standardisation of the Apparatus.*

The necessary operations were as follows:—

No. 1. Determination of the temperature coefficient of coils and bridge-wire.

[1] See letter to NATURE, October 17, 1895.

No. 2. Calibration of bridge-wire and determination of error due to the position of the scale zero mark.

No. 3. Determination of the coil errors.

No. 4. Value of the mean box-unit in terms of the Board of Trade ohm. (This was *not* a necessity for the temperature measurements, but it appeared advisable to ascertain it.)

No. 5. Determination of R_1 R_0 and δ for each thermometer.

It is impossible to give any full description of the operations—I can but indicate the methods adopted.

No. 1 has already been described *supra*.

No. 2. A length of 4 c.m. of an unused portion of the bridge-wire was soldered across the thick posts supporting the coil marked FI; thus if balance was obtained with the plug FI in, its withdrawal would compel a movement of about 2 c.m. in the contact-maker to restore equilibrium. As the constitution of both wires was the same, and as they were included in the glass case, the length moved by the contact-maker was unaltered by changes in temperature.

C_1 C_2 (Fig. 1) were connected by a thick copper strip, while p_1 and p_2 were connected with the terminals of a resistance-box (r_1) having a slightly larger unit than the Kew box, and the extremities of r_1 were connected with two other boxes (r_2, r_3), of which r_2 could be altered by certain steps from 5 to 20,000 ohms, and r_3 by any quantity from 0·1 to 10,000 ohms; thus r_2 and r_3 may be regarded as shunts to r_1. All three boxes were maintained at a constant temperature.

This arrangement was adopted to enable a balance to be obtained when the contact-maker was at, or very near any given position; for example—suppose contact desired at reading + 15, r_2 and r_3 were made as large as possible, and r_1 adjusted until the bridge-wire reading somewhat exceeded 15; r_1 was then reduced until the reading but slightly exceeded 15. Reductions of some hundreds of ohms in r_3 would now cause but small alteration in the combined resistance of the three boxes, provided r_3 greatly exceeded r_1 and r_2 when in parallel arc. It was thus always found possible and easy to balance so that contact was nearer than 0·5 m.m. to any desired position.

The plug FI was now withdrawn, and the corresponding movement of the contact-maker noted. Repeated observations throughout the whole length of the wire were thus taken, not only by the writer, but also by Mr. G. M. Clark, who performed an independent series. Denote the resistance of the wire across FI by U, then the reciprocals of the observed lengths give in terms of U the effective resistance per c.m. of the wire at the middle point of each range. By means of the arrangement described above, the observations were so conducted that these middle points fell almost exactly on the integral numbers of the scale, and, by plotting, the exact values at the integers were obtained.

By repeating the process with the plug H the value of U in terms of H could be accurately ascertained, and a check was also obtained on the previous observations. The value per c.m. for the whole wire could thus be found in terms of H. Later in the operations, when the value of H was known in terms of the mean box unit, the b.-w. values were expressed in terms of the mean unit and integrated on each side of the zero mark.

No. 3. The effect of any inequality in the bridge arms of S_1 S_2 (Fig. 1) could not be eliminated by means of the Correction Tables, nor could such an error be easily detected by means of the box itself, as is the case in the remaining coils. Great attention was, therefore, devoted to securing equality. It is certain that they do not differ by 1 in 100,000.

The errors of coils A to H and FI (the temporary connection across FI having been removed) were now determined by a method originally adopted by Prof. Callendar. No great efforts were made to secure the identity of these coils with their nominal values, for it was certain that some small corrections would in any case be necessary, and as the magnitude of the correction in no way increases the labour of calculation, the time and energy expended in any exact adjustment would have been wasted.

The procedure was as follows:—

All plugs were inserted, and the balance obtained with the contact-maker at any convenient position by adjusting r_1, r_2, r_3, as previously described. H (5) was then removed, and the change in reading required to readjust balance observed. Let Z_1 be the consequent change in reading; r_1, r_2, r_3 were then altered until the contact-maker was brought back to about the same position as it occupied when H was in. H was then inserted, and G (10) removed. Let change $= Z_2$; contact was again brought to first position, D (20) removed, and G and H replaced. Let change $= Z_3$, &c.

When the process is completed we thus get a series of equations

$$A - (B \text{ to } H) = Z_8$$
$$B - (C \text{ to } H) = Z_7$$
$$C - (D \text{ to } H) = Z_6, \text{ \&c.}$$

By subtraction we then get

$$A - 2B = Z_8 - Z_7$$
$$B - 2C = Z_7 - Z_6, \text{ \&c.}$$

Now the values of Z_1 Z_2, &c., *in terms of H* are already known from the previous operations, hence A, B, &c., in terms of H can be found.

As the right-hand extremities of the intervals Z_1 Z_2, &c., were approximately in the same position, nearly the same portion of the bridge-wire was used throughout; thus any errors in the previous calibration would but slightly affect the results.

Knowing the values of all the coils in terms of H, it is then easy to express them all in terms of the mean coil, and hence in terms of the mean box unit, a corresponding correction being made in the integrations of the bridge-wire.

The zero error of the scale was next determined by reducing the resistances between C_1, C_2, and P_1, P_2 (Fig. 1) to zero, and replacing all plugs. The observations were checked by reversing all the connections. The displacement was found to be + 0·005 c.m.

No. 4. Finally the sum of all the coils was determined by means of a dial box, of whose comparison with the B.A. Standard full particulars are given in *Phil. Trans.* A, 1893, pp. 407–410. The result was that the mean Kew box unit at 20° C. = 0·0099993 Board of Trade ohms.

At the conclusion of the standardisation a large number of readings of the same resistance were taken by different observers with different combinations of coils and b.-w. readings. The accuracy of all the corrections was thus exposed to a crucial test, the results of which were satisfactory.

No. 5. The standardisation of the thermometers was performed after the installation of the apparatus at Kew, the previous observations having been made in my own laboratory.

I find that many misapprehensions are prevalent as to the nature of the operations, and it may therefore be of assistance to observers who standardise their own thermometers, if I give a complete example of one set of the observations as taken at Kew, together with their reductions. I select thermometer K_2, as several observers took part in its standardisation, and it therefore well illustrates the order of accuracy obtainable.

The numbers in italics show the corrections resulting from the standardisations of which an account has been given. The times are always entered, since the observations of the barometer cannot be taken simultaneously with the temperature measurements, and it is necessary, therefore, when working with steam and sulphur, to form a time-chart by which to ascertain the correct pressure at the moment of observation.

Thermometer K_2. *Determination of* R_0.

Date and observer.	Time.	Coils and correction.	B.-wire and correction.	Temp. box and correction.	R_0
Oct. 2, 1895					
C.T.H.	11.47	C.D.F. = + 260 + *·035*	− 2·302 + *·004*	21·38 + *·092*	257·829
E.H.G.	11.50	,,	− 2·306 + *·004*	21·36 + *·091*	257·824
W.H.	11.57	C.D.F.H. = 265 − *·023*	− 7·260 + *·022*	21·33 + *·089*	257·828
C.T.H.	12.6	,,	− 7·263 + *·022*	21·33 + *·089*	257·825
W.H.	12.13	C.D.H. = 245 + *·014*	+ 12·784 − *·059*	21·32 + *·088*	257·827
				Mean	257·827

The separate determinations were entirely independent, and taken by three different observers; the coils were so changed that the b.-w. readings altered from $-7·263$ to $+12·784$, while the sum of the corrections varies from $+0·131$ to $+0·043$, yet the greatest departure from the mean $= 0·003$.

Thermometer K_2 *in Steam.*

Date and observer.	Time.	Coils and correction.	B.-wire and correction.	Temp. box and correction.	Bar. and temp. F.	R^1
Oct. 2, 1895 C.T.H.	12.37	C.D.F.FI. = 360 − *·008*	− 2·820 + *·007*	21·30 + *·121*	29·602 at 61·2	357·300
E.H.G.	12.42	,,	− 2·824 + *·007*	21·30 + *·121*	29·600 at 61·2	357·296

The barometer reading at 12.37 corrected for temperature, and for g to sea-level, lat. $45° = 750·12$ m.m., and at $12.42 = 750·06$ m.m. (This difference of ·06 m.m. corresponds to a decrease of 0·002 in R.)

Hence mean pressure $= 750·09$ m.m., and temperature of steam at this pressure $= 99°·634$ C.

$\therefore \dfrac{347·298 - 257·827}{99·634} =$ *mean* change in R per 1° C. over this range.

Now $\dfrac{\delta pt}{\delta t} = 1 - \delta\dfrac{2t - 100}{10,000}$. We may assume δ for this wire as approximately 1·50.

Hence

$$\frac{\delta pt}{\delta t} = 0·985, \quad \therefore \frac{\delta R^1}{\delta t} \text{ at } 100° = ·9982 \times ·985 = ·983,$$

$$\therefore \delta R^1 \text{ for } 0·366° \text{ C.} = 0·360.$$

Hence

$$R_1 = 357·298 + ·360 = 357·658.$$

Thermometer K_2 *in Sulphur-vapour.*

Date and observer.	Time.	Coils and correction.	B.-wire and correction.	Temp. box.	Mean bar. and temp. F.	R.
Oct. 2, 1895 E.H.G.	1.50	A.F.G.H. = 675 − *·207*	+ 2·789 − *·013*	21·15 + *·203*		677·772
E.H.G.	1.53	,,	+ 2·796 − *·013*	21·14 + *·201*		677·777
E.H.G.	1.58	A.E. = 680 − *·089*	− 2·343 + *·004*	21·13 + *·201*	29·610 at 61·5	677·773
W.H.	2.20	,,	− 2·322 + *·004*	21·04 + *·183*		677·776
					Mean	677·775

Here, again, changes in coils and b.-w. readings do not appreciably affect the results. It is interesting to notice that the change in box temperature between 1.58 and 2.20 p.m. almost exactly accounts for the difference of 0·021 in the b.-w. readings by the different observers. As the apparatus had but just been installed, we had not got the regulator properly under control; thus the temperature changes were greater than would usually be the case.

Barometer, corrected as before $= 750·30$ m.m.

Now, b. p. of sulphur

$$= 444·53 + (p - 760) \times ·082 = 443·73,$$

and

$$pt_s = \frac{677·775 - 257·827}{357·658 - 257·827} = 420·66.$$

Hence, Eq. (d),

$$443·73 - 420·66 = \delta(4·437^2 - 4·437),$$

$$\therefore \delta = 1·512.$$

Thermometer K_2 is now completely standardised.

Constants

$$R_1 = 357·658 \quad \frac{R_1}{R_0} = 1·3872$$

$$R_0 = 257·827$$

$$FI = 99·831 \quad \delta = 1·512.$$

The most simple manner of obtaining the value of t for any given value of pt is to proceed as follows. Construct, by means of Eq. (d), a table giving corresponding values of pt and d for regular increases in t or pt, assuming the value of δ as 1·500. (For convenience of those using these thermometers, I give such a table, as an appendix, for values of pt up to 1000.) Plot the numbers thus obtained on a large scale with pt as abscissa and d as ordinate. Having experimentally found pt in a certain case with a thermometer whose value of δ is δ^1, ascertain from the chart the corresponding value of d, then $t = pt + \dfrac{\delta^1}{1·500} \times d$, and thus the same chart can be used for different thermometers.

The above example will suffice both to illustrate the general method and the standardisation of the Kew thermometers.

IV. *Concluding Remarks.*

I understand that the Kew Committee had two objects in view when they sanctioned the acquisition of this apparatus and undertook the task of directing a course of observations.

(1) To submit the methods and principles of platinum thermometry to an exhaustive trial, and especially to ascertain how far the apparatus would stand the test of time and use. Such a series of observations can only be undertaken by a department similar to that at Kew, where records are properly kept, and where the continuation of the experiments is not dependent on the life or inclination of individual observers.

(2) To establish some recognised system of standardisation for instruments intended for the measurement of high temperatures.

With regard to the latter object, I would venture to add a few remarks. If high-temperature mercury thermometers (such as those of Niehls, of Berlin) are sent for comparison, it must be remembered that the readings of these instruments are greatly influenced by the stem temperature, especially when the range is large, and it is impossible, under the conditions usually prevalent in high temperature measurements, to secure complete immersion of the stem. The observers at Kew will be able to state the length of the portion actually immersed, &c., and those who afterwards use such thermometers must endeavour, if they wish for accurate results, to reproduce the conditions as nearly as possible. The experience of Messrs. Heycock and Neville in their earlier work (when they used for their experiments mercury thermometers standardised by platinum ones)[1] shows that it is possible to reproduce the original conditions with sufficient accuracy.

Again, it is useless to standardise glass thermometers unless previous experience has shown that they are not subject to the zero rise usually characteristic of such instruments after exposure to high temperatures.

Another matter, to which I trust the attention of Dr. Chree will sometime be directed, is the suitability of platinum standards for the calibration of mercury thermometers *at ordinary temperatures*. The greatest value of d over the range 0° to 100° (*i.e.* near 50° C.) is with these standards less than 0°·4 C.; now an error of 1 per cent. in δ (and I do not believe that any such error is probable, or I may say possible) would mean an error of but 0°·004 in t at 50° C., and less at other temperatures. The readings are independent of changes in internal or external pressure, of position or of stem immersion, and are directly expressed in terms of the air thermometer. It was with a view to such comparisons that I designed K_6, which on account of the large value of FI would cause an error of ·003 in the readings to affect the resulting value of t by only 0°·001 C.

[1] *Chem. Soc. Journ.*, July 1890.

In conclusion, I may be permitted to express my gratification that the efforts made by Prof. Callendar and myself to demonstrate the accuracy and convenience of the methods of platinum thermometry are, although progress has been slow, at length awakening the attention of scientific inquirers. We believe (and that belief is founded not only on our own experience, but more especially on the work of Messrs. Heycock and Neville) that it is by means of the platinum thermometer that the many difficulties attendant on thermometric measurements, either at high or low temperatures, can be most easily surmounted.

Although the acquisition and installation of the apparatus has involved a considerable expenditure of both time and money, I am confident that, under the able direction of Dr. Chree, the results will justify the action of the Committee.

APPENDIX.

The following table gives the relation between the platinum temperature scale and the air temperature scale, when the value of $\delta = 1\cdot500$.

Platinum temperature scale.	Correction.	Air temperature scale.	Platinum temperature scale.	Correction.	Air temperature scale.
− 100	+ 2·9	− 97·1	450	+ 27·0	477·0
− 50	+ 1·1	− 48·9	500	+ 34·9	534·9
0	0·0	0	550	+ 44·0	594·0
50	− 0·4*	49·6	600	+ 54·4	654·4
100	0·0	100·0	650	+ 66·2	716·2
150	+ 1·2	151·2	700	+ 79·4	779·4
200	+ 3·1	203·1	750	+ 94·2	844·2
250	+ 6·0	256·0	800	+ 110·7	910·7
300	+ 9·8	309·8	900	+ 149·4	1049·4
350	+ 14·5	364·5	1000	+ 197·0	1197·0
400	+ 20·2	420·2			

* More accurately = − 0·375 and 49·625.

E. H. GRIFFITHS.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—It is announced that the electors to the Waynflete Professorship of Mineralogy will proceed to the election of a Professor in the course of the present year. Candidates are required to send to the Registrar of the University, on or before December 7, their applications and testimonials.

The University having accepted a bequest of £900, given by the will of the late Mrs. Fielding, for the purpose of providing for the payment of a Curator of the Fielding Herbarium, it has been decreed that there shall be a Curator of the Herbarium, appointed by the Fielding Curators, and under the direct control of the Sherardian Professor of Botany. Besides the income derived from the bequest of £900, the Curators shall have the power to apply a part of the funds at their disposal to the increase of the stipend of the Curator of the Herbarium.

The following Examiners have been approved by Convocation:—For the first examination for the degree of Bachelor of Medicine, W. R. Dunstan, G. W. S. Farmer, and Dr. R. Stockman; for the second examination for the degree of Bachelor of Medicine, Dr. C. W. Mansell Moullin, Sir William Stokes, G. E. Herman, and Dr. S. H. C. Martin. In each case the appointments are for the examinations of 1896, 1897, and 1898.

CAMBRIDGE.—Mr. T. W. Bridge, Professor of Zoology in the Mason College, Birmingham, and Mr. G. H. Bryan, F.R.S., of Peterhouse, have been approved for the degree of Doctor of Science.

Mr. C. T. R. Wilson, of Sidney Sussex College, has been elected to the Clerk Maxwell Studentship in Experimental Physics.

The late Miss Jane Saul has left her collection of shells, and the cabinet containing the same, her "Conchologia Iconica," and other conchological works, to the University.

MR. J. GAD, Extraordinary Professor of Physiology in Berlin University, has been appointed Ordinary Professor of the same subject, and Director of the Physiological Institute in the German University at Prague. Dr. M. von Lenhossek, of Wurzburg, has been appointed Prosector in the Anatomical Institute at Tübingen. Other recent appointments are: Dr. Mark W. Harrington to be President of Washington State University; Mr. H. Landes to be Professor of Geology in the same University, and Dr. H. C. Myers to be Professor of Chemistry.

DR. C. M. LUXMORE has been appointed to a Research Fellowship of the Pharmaceutical Society.

MR. JAMES WILSON, Lecturer in Agriculture, University College, Aberystwyth, has been appointed to the Fordyce Lectureship in Agriculture in Aberdeen University.

FROM the *Journal* of the Society of Arts it appears that the great advances made by Swiss national industry during the last fifteen or sixteen years, both in the technical and artistic character of its products, are attributed by the *Deutsches Handels Archiv* to the beneficial influences of State and Municipal establishments for technical education. It is very remarkable how much is done in the cantons of Geneva and Neuchatel to encourage and improve local industries, especially in finer classes of goods, for the manufacture of which a considerable amount of skill and artistic knowledge is required. In these two cantons, numbering little more than 220,000 inhabitants, there are five schools for watchmakers, and in Geneva, Neuchatel, and Chaux de Fonds there are schools for instruction in the fine arts and in artistic handicrafts. Besides the institutions there are commercial schools in Geneva and Neuchatel, and the professional schools in which instruction in various industries is given to persons of both sexes. In the watchmaking school at Geneva a class for girls has recently been established, where certain operations peculiarly suitable for female labour are taught. Considerable assistance is also rendered to the watch industry by the astronomical observatories at Geneva and Neuchatel, both by testing chronometers, and by their co-operation in the annual trade competitions.

SCIENTIFIC SERIALS.

Internationales Archiv für Ethnographie, Band viii. Heft iv. —This well-illustrated journal is steadily increasing in value and interest, as it is wider in its scope than it was at the commencement. Baron van Hoëvell, of Amboina, has a paper on a few notes on the kinds of the worship of gods in the south-western and south-eastern islands of the Malay Archipelago. Amongst other interesting information is a legend of the origin of two fetiches which are said to have fallen from heaven; one, which is called a sword, is probably a piece of old hoop-iron, and the other, a supposed spear-point, appears to be a piece of meteoric iron. There are also traces of a virginal conception through divine influence.—"Dogs and Primitive Folk" is the title of a comprehensive essay by Dr. B. Langkavel, in which he deals with dogs in folk custom and belief, the name as a term of reproach, ornaments derived from dogs, &c.—Dr. O. Frankfurter writes on dreams and their significance according to a Siamese dream-book.—J. D. E. Schmeltz has three communications on Papuan ethnography, of which the first, on objects from the Tugeri, is the most interesting. We are now beginning to learn something definite about these ruthless pirates that harass the western coast population of British New Guinea. A bow, tobacco-pipe, drum, and two remarkable dance ornaments are figured; the latter are slabs of wood carved to represent a flying bird (?), and several lizards or crocodiles. He also describes a wood-carving of what appears to be an echidna and some ceremonial objects. The rest of the journal is occupied with the usual notes and notices.

IN addition to articles specially interesting to Italian botanists, the *Nuovo Giornale Botanico Italiano* for July contains the following:—A study of the action of certain alkaloids on plants in darkness and in light, by Signor A. Marcacci. While quinine arrests the transformation of starch into saccharose, and of dextrose into levulose, both in the dark and in the light, strychnine does so only in the light, from which the conclusion is drawn that these changes are not simply chemical processes, but are dependent on other unknown forces. —On certain contrivances for dissemination in Angiosperms; in which more stress is laid than is generally the case on the action of water in the dispersion of seeds; as, for example, in the production of mucilage, to which the rupture of capsules is often due.—On the fruit of *Aucuba japonica*, by Signor L. Pampaloni.—On the affinities of the *Sphenophyllaceæ*, by Prof. G. Arcangeli. The author regards this group of fossil plants as having

no near affinity with any other, either palæontological or recent. While the structure of the stem resembles that of the *Calamarieæ*, the mode of formation of the spores is analogous to that of the *Lycopodiaceæ*.—On the development of *Tricholoma terreum*, by Signor P. Voglino.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 8.—Prof. A. W. Rücker, Vice-President, in the chair.—Mr. W. H. Everett read a paper on the magnetic field of any cylindrical coil or plane circuit. The method of treatment is based on the formula for the force due to an element of current. A single integration applied to one component of this force gives for any point in the field due to a plane circuit the force perpendicular to its plane; and a double integration gives the longitudinal force at any point due to a cylindrical coil of any cross-section, the depth of winding being supposed inconsiderable. For coils in which the latter condition does not hold, an approximate solution can readily be found. The force parallel to the plane of a circuit and the transverse force due to a coil are investigated in a similar manner. The general results are of a very simple form, and admit of easy approximate calculation. Special formulæ are deduced for coils of rectangular cross-section, the general expressions being in this case integrable. Appended to the paper are some numerical results giving the values of the forces at different points due to coils of various dimensions. Prof. Perry said he considered the paper to be a valuable one, particularly as illustrating a practical mathematical method of integrating. Mr. Trotter said the paper was of interest to him, as he considered that several of the author's results might be applied to the solution of problems on illumination—for instance, the illumination of a room by a circle of lamps. Mr. Rhodes regretted that it had not been possible to supply a proof of the paper before the meeting. The method in which the author obtained the force outside a solenoid as the difference of the forces due to two solenoids, reminded him of the method employed in calculating the attraction of, say, a truncated pyramid. Prof. Silvanus Thompson said the author had mentioned several previous papers on the subject, but had not referred to one by Prof. Viriamu Jones, in which the force due to a solenoid is obtained in terms of elliptic integrals. Another method of attack was to calculate the work done when a unit pole is carried through the solenoid and back outside to the starting-point. Prof. Ayrton said he also regretted the absence of a proof of the paper. He considered it of great importance to have exact and simple methods of calculating the forces due to a solenoid. The Chairman (Prof. Rücker) said he had made a somewhat similar calculation in connection with the magnetic effect of sheets of basalt below the surface of the earth.—Mr. E. H. Griffiths read a paper, by himself and Miss Dorothy Marshall, on the latent heat of evaporation of benzene. The method employed is similar to that used by one of the authors in the determination of the latent heat evaporation of water (*Phil. Trans.* 1895). The loss of heat due to the evaporation is balanced by (*a*) the heat supplied by an electric current; (*b*) a secondary supply due to the work done by the stirrer; (*c*) a slight gain or loss due to small unavoidable changes in temperature of the calorimeter. The comparative values of the various sources of heat (if we denote the supply due to the electrical current by 1000) is approximately:—Electrical = 1000; stirring = 11; changes in calorimeter temperature ± 5. The electrical supply could be measured with extreme accuracy, and the above table shows that small errors in the determination of the remaining thermal quantities are of little importance. The results may be summed up in the formula

$$L = 107{\cdot}05 - 0{\cdot}1981\,\theta$$

where θ is the temperature and the thermal unit at 15° C. is used. The discussion on this paper was postponed till after the reading of the paper by Prof. Ramsay and Miss Marshall, on a method of comparing the heats of evaporation of different liquids at their boiling points. The method employed has already been described before the Society (January 11, 1895). The liquid to be experimented on is put into a glass bulb enclosed in an outer jacket filled with the vapour of the same liquid. An open tube is attached to the top of the bulb, so that there is free communication between the interior and the vapour jacket, and no loss of material. Inside the bulb is a spiral of fine platinum wire, attached to stout platinum terminals which are sealed into the glass. The temperature of the liquid in the bulb is raised to the boiling point by the vapour jacket; thus when a current is sent through the wire, the whole of the heat developed is spent in converting a portion of the liquid into vapour. Two such bulbs are connected in series, and the ratio of their losses of weight is the inverse ratio of the heats of evaporation of the liquids. A correction is made for the inequality in resistance of the spirals, and the ratio of the differences of potential between the ends of the spirals, when the current is passing, is determined in each experiment by Poggendorff's method. Results are given for fourteen liquids. Prof. Ramsay drew special attention to the table giving the values of the quotient ML/T, where M is the molecular weight, T the absolute temprature, and L the latent heat. Very curious differences are noticeable in the case of water, alcohol, and acetic acid. Prof. Carey Foster expressed his admiration for the method, since it obviated the necessity of knowing the specific heat of the liquid vapour. Prof. Silvanus Thompson said the difficulty experienced in the case of water due to electrolysis might be obviated by the employment of a spiral of lower resistance and a larger current, so that the difference of potential between the ends of the spiral should be less than 1·7 volts. The Chairman said Captain Abney had asked him to inquire to what extent the temperature of the liquid was affected by radiation. Mr. J. W. Rodger asked if any direct experiment had been made to determine if the temperature of the liquid was not above its true boiling point. In some cases differences of as much as 2° might exist between the temperature of the liquid and that of the vapour given off. The differences in the value of ML/T in the case of water, alcohol and acetic acid might be due to the fact that the vapours of alcohol and water were simple, while the vapour of acetic acid was complex. Mr. R. Appleyard suggested that the differences obtained in the case of water might be due to the presence of dissolved air. Mr. Griffiths said that the objection to the adoption of Prof. Thompson's suggestion was the fear that with short wires an excessive difference in temperature between the wire and the liquid might exist. Mr. Rhodes asked if Mr. Griffiths could trust his determinations of temperature to $\frac{1}{50000}$th of a degree. Mr. Griffiths, in reply, said that he thought there was no limit to the accuracy with which a difference of temperance could be measured; the absolute temperature, however, he only relied upon to $\frac{1}{1000}$th of a degree. Prof. Ramsay said the fact of superheating existing would not affect the results, since near the temperatures at which they were working the latent heat did not vary appreciably with the temperature. In reply to Captain Abney, he said some previous experiments by Dr. Young and himself had shown that the vapour jacket was quite impervious to radiant heat from without

PARIS.

Academy of Sciences, November 4.—M. Marey in the chair.—Action of silicon on iron, chromium, and silver, by M. Henri Moissan. By heating silicon with soft iron, chromium, or silver in the electric furnace or otherwise, compounds having the composition Fe_2Si and Cr_2Si are produced by the two former metals, and silver dissolves a notable proportion of silicon, but deposits it again on solidification in the crystalline state. The silicides of iron and chromium are produced at temperatures below the melting points of either constituent, probably owing to the vapour tension of silicon at the temperature of formation; the whole process much resembles cementation. These silicides are readily attacked by hydrofluoric acid or aqua regia, slowly acted on by hydrochloric acid and unacted on by nitric acid. Fused potassium nitrate and chlorate do not act on these compounds, but they are easily decomposed by fusion with a mixture of nitrate and carbonate.—M. de Freycinet describes the aim of his book, "Essays on the Philosophy of the Sciences," of which a copy is presented to the Academy.—Elements of Swift's comet (1895 II), by M. L. Schulhof. These elements are compared with the elements for Lexell's comet given in Le Verrier's table (for $\mu = + 0{\cdot}9$), and show very near agreement.—Spectroscopic researches on the star Altaïr. Recognition of an orbital movement and of an atmosphere, by M. H. Deslandres. (See our Astronomical Column.) On the binomial differential equation of the first order, by M. Michel Petrovitch.—New method for the extraction of roots of numbers, by M. Manuel Vazquez Prada.—Expression of the pressure supported by the shaft of a hydraulic turbine at work. Theorem concerning the dynamical effect of the water. Note by M. Bertrand de Fontviolant. It is concluded that: The

dynamical effect is equal to the geometrical variation of quantity of movement suffered by the volume of water delivered per second in its passage across the turbine.—On the time distribution of rain at Athens, by M. D. Eginitis.—On the process of attacking the emerald and the preparation of pure glucina, by M. P. Lebeau.—On a group of mineral waters containing ammonia (bituminous waters), by M. F. Parmentier.—On the estimation of tannins in wines, by M. E. Manceau.—Action of chlorine on normal propyl alcohol, by M. André Brochet. Two of the products of chlorination in the cold are α chloropropionic aldehyde, $CH_3 . CHCl.COH$, and dipropyl chloropropional, $CH_3 . CHCl.CH(OC_3H_7)_2$.—On ozotoluene, by M. Adolphe Renard. Ozotoluene resembles the ozobenzene previously described. It is a white opaque mass, commencing to decompose at about 8°. It detonates on heating or by shock, but less easily than ozobenzene. Its composition is represented by the formula $C_7H_8O_6$.—Study on the nitration of menthone, by M. Konovaloff. By heating with nitric acid at 100° in a sealed tube menthone yields nitromenthone $C_{10}H_{17}(NO_2)O$. The alcoholic solution of the latter with sodium ethoxide gives a salt, undecomposed by boric, carbonic, or hydrosulphuric acids, corresponding to the acid $C_{10}H_{19}NO_4$ set free by sulphuric acid. The nitromenthone is reduced with formation of a basic substance. It is probably a tertiary nitromenthone of the composition

$$CH_3.CH\left\langle\begin{matrix} CH_2 - CH_2 \\ CH_2 - CO \end{matrix}\right\rangle C(NO_2).C_3H_7.$$

—On the fermentation of cellulose, by M. V. Omelianski. The specific ferment destroying cellulose has been isolated by the author, and is described in the paper.—Anatomy of the digestive apparatus of the Orthoptera of the family of the *Forficulidæ*, by M. Bordas.—On the application of the experimental method to the orogenic history of Europe, by M. Stanislas Meunier.—Experiments relative to the direct manufacture of pure ethyl alcohol, by the fermentation of *Asphodelus ramosus* and *Scilla maritima* with cultivated pure wine yeasts, by M.M. G. Rivière and Bailhache.—On the reclamation of the heath-lands of the Dordogne, by M. Raoul Bouilhac. It is shown that the reclamation of these sandy barrens is possible by the use of a lime phosphatic manure.—Experimental congenital deformities, by MM. Charrin and Gley.

AMSTERDAM.

Royal Academy of Sciences, September 28.—Prof. Van der Waals in the chair.—Mr. Jan de Vries read a paper on addition theorems for elliptic integrals.—Prof. Kamerlingh Onnes communicated measurements, made in the Leyden laboratory, and already published in Dr. Lebret's dissertation (July 1895) on the variation with temperature of the Hall effect in bismuth, the temperatures ranging from $-74°$ to $+240°$. Two samples of pure bismuth were experimented upon. The temperature curve of one of the specimens showed a maximum point at $-20°$; that of the other was not examined far enough. The latter specimen was melted up into a glass tube, and the variation in the electrical resistance measured between $-76°$ and $+240°$.—At the request of Prof. Cohn of Strassburg and of Dr. Zeeman of Leyden, Prof. Onnes gave an account of experiments, made partly at Strassburg and partly at Leyden, on the propagation of electrical waves in water. The result was: (1) there is no dispersion for waves of the oscillation frequency of 27 to 97 millions per second; (2) the refractive index for waves of which there are a hundred millions a second, is equal to the square root of the specific inductive capacity as measured by the statical method.—Prof. Onnes further communicated: (1) a measurement on the refractive index of glowing platinum, made by Dr. Zeeman in the Leyden laboratory. With Babinet's compensator it was impossible to establish a variation with temperature of the principal incidence and the principal azimuth, even when the platinum mirror was heated to 800° C. Hence within the limits of the errors of measurement the refractive index does not change; (2) a chart, showing the secular variation of magnetic declination, by Dr. W. van Bemmelen; (3) photographs of vibrating strings made by a new method, that of intermitting photography, by Dr. H. J. Oosting.—On behalf of Messrs. C. A. Lobry de Bruyn and W. Alberda van Ekenstein, Prof. Franchimont presented a paper on the reciprocal conversion of glucose, fructose and mannose into one another under the influence of alkalis.—Mr. van Diesen called attention to a copy, now in the library of the Academy, of the second edition of the map of North Holland, made in 1575, by order of the Duke of Alva, by Joost Jansz. Beeldsnÿder. Of the first edition no copy seems to be extant in Holland. The copy shown is the edition published in 1610 by H. A. van Warmenhuysen. Though the map seems to have been prepared with care as regards local details, the triangulation is not correct. The "mile," given as scale, probably the Spanish mile, has on this copy a length of 73 m.m.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Story of the Earth in Past Ages: Prof. H. G. Seeley (Newnes).—Birds from Moidart and Elsewhere: Mrs. H. Blackburn (Edinburgh, Douglas).—Zoological Record, Vol. xxxi. (Gurney).—Histoire de la Philosophie Atomistique: L. Mabilleau (Paris, Alcan).—Geological Survey of Canada, various Maps, (Ottawa).—An Introduction to the Algebra of Quantics: Prof. E. B. Elliott (Oxford, Clarendon Press).—The Reliquary and Illustrated Archæologist, new series, Vol. 1 (Bemrose).—Analyse des Alcools and des Faux-de-Vie: X. Rocques (Paris, Gauthier-Villars).—Applications Scientifiques de la Photographie: G. H. Niewenglowski (Paris, Gauthier-Villars).—Fourth Volume of Reports upon the Fauna of Liverpool Bay, &c. (Liverpool, Dobb).—A Primer of the History of Mathematics: W. W. R. Ball (Macmillan).—Science Readers: V. T. Murché, Books v. and vi. (Macmillan).—The Natural History of Eristalis Tenax, or the Drone Fly: J. B. Buckton (Macmillan).—Studies in Economics: Dr. W. Smart (Macmillan).—The Life of Joseph Wolf: A. H. Palmer (Longmans).—Stanford's Compendium. Africa, Vol. 2: South Africa: A. H. Keane (Stanford).—Elementary Physical Geography: Prof. R. S. Tarr (Macmillan).—Elementary Physiography: J. Thornton, 8th edition (Longmans).—The Intellectual Rise in Electricity: Dr. P. Benjamin (Longmans).

PAMPHLETS.—De la Double Réfraction Elliptique et de la Tétraréfringence du Quartz: Prof. G. Quesneville (Paris).—The Rutherfurd Photographic Measures of Sixty-two Stars about η Cassiopeiæ: H. S. Davis (New York).—Clouds and Weather: Captain D. Wilson-Barker (*Shipping World* Office).

SERIALS.—Princeton Contributions to Psychology, September (Princeton, N.J.).—Zeitschrift für Wissenschaftliche Zoologie, lx. Band, 2 Heft (Leipzig, Engelmann).—Geographical Journal, November (Stanford).—Bulletin of the American Mathematical Society, October (New York, Macmillan).—L'Anthropologie, tome vi. No. 5 (Paris, Masson).—Zeitschrift für Physikalische Chemie, xviii. Band, 2 Heft (Leipzig, Engelmann).—Scribner's Magazine, November (S. Low).—Geological Magazine, November (Dulau).—Journal of the Chemical Society, November (Gurney).—History of Mankind: F. Ratzel, Part 2 (Macmillan).—Mathematical Gazette, October (Macmillan).—Science Progress, November (Scientific Press, Ltd.).—The Evergreen, Autumn (Unwin).—Journal of the American Public Health Association, October (Concord).—Proceedings of the Physical Society of London, November (Taylor).—Journal of the Franklin Institute, November (Philadelphia).—American Naturalist, November (Philadelphia).—Engineering Magazine, November (Tucker).

CONTENTS.

THURSDAY, NOVEMBER 21, 1895.

HYDRODYNAMICS.

Hydrodynamics. By Horace Lamb, M.A., F.R.S., Professor of Mathematics in the Owens College, Manchester. (Cambridge: University Press, 1895.)

THE original edition of this work, published in 1879 under the title of a "Treatise on the Mathematical Theory of the Motion of Fluids," gave the first impulse to the cultivation in this country of the modern developments of Vortex and Cyclic Motion, with their Electromagnetic Analogues, the Discontinous Jets of Helmholtz and Kirchhoff, the Dynamical Theory of the motion of perforated solids through a liquid, and the examination, as far as possible, of the effects of Viscosity. Previous writers had confined themselves to simple applications of the principle of Parallel Sections, to the bodily rotation of liquid, especially of Ellipsoids, and to simple cases of Wave Motion and of Tidal Phenomena.

The analysis invented by Helmholtz for the special case of a discontinuous jet has led, in Schwartz's hands, to important developments in the Theory of Functions, which still receive their most convincing explanation by a return to the hydrodynamical analogue. A recent article in the *Math. Annalen*, 1895, by Réthy, on this subject deserves attention. So too, in the present treatise, the author introduces much of the modern Theory of Functions, guided by considerations of physical interest; but long analytical investigations, leading to results which cannot be interpreted, have, as far as possible, been avoided.

The author quotes Poinsot's warning, "Gardons nous croire qu'une science soit faite quand on l'a réduite à des formules analytiques," as especially applicable to the present branch of mathematical physics; so he has made the analytical results convincing and intelligible by numerical illustrations, and by the insertion of a number of diagrams, drawn carefully to scale and reduced by photography. The hope expressed by the author that the results of his numerical calculations will be found correct is a natural feeling to those mathematicians who find by experience that it is no small difficulty to make use of a formula by turning its results into numbers.

The so-called practical man can use a formula in this manner, without understanding the theory upon which it is based; on the other hand the mathematical student is apt to imagine that, after the formula has been demonstrated, it is an easy matter, hardly worthy of his attention, to turn the formula to account in a numerical application, until humiliating experience teaches him his error.

The subject is opened out in the initial chapters in much the same manner as in Basset's "Hydrodynamics." The method of Conjugate Functions, now more commonly called Harmonic Functions by continental writers, is a powerful machine for the construction of results of motion in two dimensions; it is unfortunate that the method cannot be extended to three dimensions, except when the motion is symmetrical about an axis, when Stokes's stream or current function presents a certain analogue.

The hydrodynamical questions which can be solved by the system of coordinates given by confocal quadrics are very fully explained in Chapter v.; for instance, the motion of liquid due to the presence of an ellipsoid. A very slight extension of the author's method enables us to dispense with an infinite extent of liquid, and to suppose it bounded externally by another confocal, useful when the oscillations of gravitating liquid between two confocal ellipsoids is to be considered; so also the author's own investigations in the preceding chapter of the motion due to an infinite elliptic cylinder can be completed and amplified in a similar manner. We miss, too, the special consideration of confocal paraboloids, where the liquid necessarily extends to infinite distance; also the discussion of the motion of the liquid filling a rectangular box. Mr. Basset's method of exhibiting the result by two symmetrical infinite series, due to Dr. Ferrers, can be illustrated by supposing each series to represent the effect of a shearing velocity in the shape of the box, the superposition of the conjugate shear producing the same effect as a rotation.

Prof. Lamb apparently does not approve of our insular plan of collections of examples interspersed in the Chapters; but many important results, for which room cannot be found without unduly swelling the book, can in this manner receive mention, as in Basset's treatise.

The plane motion of a solid through infinite liquid is worked out completely, with accurate diagrams, in Chapter vi., the error of supposing that the path of the body can be looped when there is no circulation, is corrected; but we notice incidentally that, among all the various functions employed by the author, the elliptic functions are conspicuous by their absence. Kirchhoff's equations for the general motion of a solid of revolution in space filled with liquid afford appropriate applications of elliptic functions, especially his curious equations giving the position of the centre of the body; but these are not given in Chapter vi.

It is always gratifying to be able to utilise some result out of the vast accumulation of analysis written on the elliptic functions; attempts are just beginning at the solution of new problems in Wave Motion embodying the functions; for instance, by Willy Wien in the *Berlin Sitz.* in discussing the effect of wind, and by Korteweg and de Vries in the *Phil. Mag.*, May 1895 in extending theorems concerning the solitary wave, given (p. 420) by

$$y = h \operatorname{sec} h^2\left(x \sqrt{\frac{h}{4\sigma}}\right)$$

to the cnoidal wave

$$y = h \operatorname{cn}^2\left(x \sqrt{\frac{h+k}{4\sigma}}\right), \kappa = \sqrt{\frac{h}{h+k}};$$

reducing to the above when $k = 0$.

The author gives a complete though rather condensed account of Vortex Motion in Chapter vii., excusing himself on the ground that the recent investigations on this subject by Lord Kelvin, J. J. Thomson, Hicks, Larmor and Love, derive most of their interest from their bearing on kinetic theories of matter, theories which lie outside the province of a treatise like the present.

But Chapter viii. gives a complete and exhaustive investigation of Tidal Waves. In these cosmical problems the sailor's units are most appropriate, the sea mile or

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sexagesimal minute of latitude and the hour; the sailor's *knot* as unit of speed can now replace the circumlocution of *sea miles per hour* of p. 274, 449, and elsewhere; but the author avoids at least the landsman's solecism of "knots an hour."

Interesting applications of Bessel functions are discussed in the chapter relating to the propagation of the tide in an estuary; it may be mentioned here that the figure for $J_0(\sqrt{x})$ on p. 295 is easily realised by revolving with appropriate speed the upper end of a vertical chain; this is the initial problem of Gray and Mathews's "Treatise on Bessel Functions."

Chapter ix. discusses the Surface Waves we are familiar with in vessels of various shapes, embodying all the results in this difficult subject which have so far been obtained. Here is a branch of Hydrodynamics which will repay the attention of young mathematicians, as every new problem solved constitutes a distinct advance in the subject; thus the determination of a state of wave motion in a canal of circular section, or in a spherical bowl, such as we see every morning at the toilet, still await solution; as also the wave motion in the gutters during a shower, when the viscosity takes a ruling part of the phenomenon.

The investigations of the effect on waves of a capillary film are easily extended to the case where the film possesses a certain superficial density, as a flag or sail, for instance, or

"—the winning wave deserving note
In the tempestuous petticoat,"—

and where the film possesses flexural rigidity, as a sheet of ice; thus the results of Kelland, Kirchhoff, and others on waves in canals are but slightly modified when the free surface is supposed to be frozen. The minimum wave velocity, where the ripples change into waves, is now shown very elegantly by Mr. C. V. Boys on a logarithmic diagram (NATURE, July 18, p. 273).

Sir George Stokes's theory of Group Velocity of Waves, introduced modestly in a Smith's Prize Question, and developed subsequently by Osborne Reynolds, has cleared up much of the mystery of the turbulence of sea waves, and explained the reason of the sailor's adage that every ninth wave is a big one, or every third wave in crossing a bar; for on this theory, if every mth wave is a big one, the motion is principally due to the superposition of two trains of waves, whose lengths are in the ratio of $(m - 1)$ to $(m + 1)$.

The author summarises very clearly the researches of Lord Kelvin and Lord Rayleigh on the wave-making due to the motion of a ship, and the complicated pattern produced in the wake of a steamer, of a duck, or even of a stick drawn through the water is illustrated in diagrams on pp. 402, 403. If the unpublished investigation referred to in the footnote of p. 403 relates to the explanation of the curious appearance of the echelon bow waves which form the fringe of the wake, where the wave fronts make an angle with the keel, the tangent of which is double the tangent of the angle between the wave fronts and the general direction of the echelon, the following extract from a letter by Lord Rayleigh will supply the deficiency:—

"A train of waves keeping up with a boat moving along Ox with velocity V_0, the crests making an angle θ with the keel, will be given by

$$a \cos k\,(Vt - x \sin\theta - y\cos\theta)$$

where

$$V = V_0 \sin\theta;$$

and the groups are due to the combination of two such trains, defined by k, $k + \partial k$; V, $V + \partial V$; θ, $\theta + \partial\theta$; subject to $V \propto \lambda^{\frac{1}{2}} \propto k^{-\frac{1}{2}}$, or $k \propto V^{-2} \propto \operatorname{cosec}^2\theta$.

The resultant is thus given ultimately by

$$2a \cos k(Vt - x\sin\theta - y\cos\theta)$$
$$\cos \tfrac{1}{2}\{\delta(Vk)t - x\partial(k\sin\theta) - y\partial(k\cos\theta)\};$$

so that if the line of echelon makes an angle ϕ with the keel,

$$\tan\phi = \frac{\partial(k\sin\theta)}{\partial(k\cos\theta)} = \frac{\delta(\operatorname{cosec}\theta)}{\delta(\operatorname{cosec}^2\theta\cos\theta)} = \frac{\tan\theta}{2+\tan^2\theta}$$

or

$$\tan(\theta - \phi) = \tfrac{1}{2}\tan\theta."$$

("Progressive Waves." By Lord Rayleigh. *Proc. London Math. Society*, vol. ix.)

Chapter x. on Waves of Expansion discusses some problems, such as oscillations of the atmosphere, but passes over the applications which belong more properly to the Theory of Sound.

To account for many observed hydrodynamical phenomena, notably of the passage of a ship through the water, the hypothesis of perfect limpidity, postulated in Chapter i., must be abandoned, and the equations of motion, such as those employed by Osborne Reynolds in his investigations on turbulent motion and skin resistance, become complicated to a formidable extent. It is, however, in this direction that the most useful line of attack on new and practical problems must be directed.

The book concludes with Chapter xii. on the Equilibrium of rotating masses of liquid, such as the spheroid of Maclaurin and the ellipsoid of Jacobi, and with a slight sketch of Poincaré's investigation of the secular stability, and of the kindred researches of Bryan and Love.

Considering that the author has already developed the requisite Spherical Harmonic analysis, we think that a *résumé* of the theory of a Figure of the Earth would have occupied very little space, and would have been very welcome, as Prof. Adams's lectures on this subject are not yet generally available.

Prof. Adams led up to Laplace's general case of strata, varying continuously in density from one to the next, by an examination of the particular cases of a spheroid composed of two, three, or more strata of uniform density; so, too, the examination of the possibility of a permanent distribution of the strata in the interior of an ellipsoidal shell which is rotating about any fixed diameter, is worthy of a careful examination by a young mathematician as an interesting research; the oscillations of such a shell have already been considered by Mr. S. S. Hough (*Proc. R. S.*, February 7, 1895).

A comparison between the present treatise and Basset's Hydrodynamics is interesting from the different modes of presentation of parts of the theory; we have reason to be proud of both as representing a branch of mathematical investigation in which foreign experts pay us the compliment of conceding that we are capable of teaching them something. A. G. GREENHILL.

GREEK TRIBAL SOCIETY.

On the Structure of Greek Tribal Society. An Essay. By H. E. Seebohm. (London: Macmillan and Co., 1895.)

In this scholarly and modest essay, the author has collected some of the evidence relating to a certain stage in the development of Greek society, the existence of which runs some danger of being insufficiently recognised by students of ancient history. "Greek" society to most people means, in the first place, the society described in the Homeric poems; in the second, Athenian society from the fifth century downwards. These limitations of the field are the natural outcome of the paramount importance of Homeric and Athenian literature; information as to the structure of society in other parts of Greece and at other periods of Greek history can, with a few exceptions, only be gleaned from incidental references in Homer and the Attic writers, and from the data afforded by comparative anthropology. To a certain extent Mr. Seebohm's field of observation may still seem to be somewhat confined, and his work would have been more valuable had the few facts known of the life of the less civilised parts of ancient Greece been more extensively utilised. To this end we could, perhaps, have spared some of the detailed discussion of the better-known survivals of tribal institutions in Athenian society of the fourth century.

Within these limits, however, Mr. Seebohm's treatment of the subject merits little but praise. His employment of the comparative method is throughout judicious. Outside the Greek world, he has utilised three main sources of information—the Old Testament, the Ordinances of Manu (a code going back in its present form probably to the fifth or fourth century B.C.), and the Welsh law. The selection, as he admits, is arbitrary, particularly in the exclusion of the Roman system from the field of comparison. But the highly-organised character of the latter is a source of danger when it is used for comparison with the looser structure under consideration, and its exclusion is therefore somewhat of a relief.

Most investigations of the structure of ancient political systems must begin with Aristotle. His treatise on "Politics," however, deals with society in its highest stage, with man's activity *τοῦ εὖ ζῆν*, not merely *τοῦ ζῆν ἕνεκα*. It is with the previous stage that we are here concerned; in fact, with what he calls "village" life—the "village" being a convenient term for the union of families, whether living close together or not, just as the state, or political union, is the combination of "villages," whether within one city-wall or scattered about a district. This "village" life has four main characteristics. As society begins in the family, the first and most important, on which all the others depend, is the bond of kinship. Secondly, the body must be organised, and this necessitates a government. The permanence of the society is maintained in two ways—by the cultivation of the land, and by the worship of the gods; in the first place those of the family, in the second those of the community. As the village is merged in the state, which reproduces on a larger scale, and therefore in a less intense degree, the relations of early society, the order of things is reversed. But the old relations continue to exist within the larger group, and it is these still-existing tribal elements that we have to trace in the complex political society.

Mr. Seebohm's work falls into two main parts, dealing with the nature of kinship, and the relation of the family to the land, thus approaching the subject from the point of view of the first and third characteristics mentioned above. Undoubtedly this is a more scientific method than that (identified with the name of de Coulanges) which commences with the religious union, or that which lays most stress on the system of government. Primitive man is not in the first instance religious; his religion is only one of the forces which he brings into play to preserve his family or tribal unity; and government is another such force. The cultivation of the land, again, is of the first necessity, unless the tribe subsists on plunder. Any properly historical investigation should therefore begin with these two matters.

With regard to the nature of kinship, a great deal of information can be extracted from the private speeches of the Attic orators. Into this part of the subject, as we have already said, Mr. Seebohm has gone very fully. Two points seem to be of special importance, the supremacy of the head of the family, and the limitation of the "inner-circle" or *ἀγχιστεία*, the group of blood-relations, "responsible to each other for succession . . . for vengeance and purification after injury received by any member, and for all duties shared by kindred blood." As regards the nature of the government of the group, there is one feature which might perhaps have been dwelt upon a little more than it has been; that is, the limitation of the supremacy of the head of the family. Every household was ruled by its oldest member; but at the same time a passage from Plato, quoted by Mr. Seebohm himself (p. 60), shows that certain measures, such as the disinheritance of a member of the family, could not be undertaken without the consent of the kindred: "He who . . . has a mind . . . to expel from his family a son . . . shall collect together his own kinsmen, extending to (first) cousins, and in like manner his son's kinsmen by the mother's side, and in their presence he shall accuse his son, setting forth that he deserves *at the hands of them all* to be dismissed from the family." This family-council is an important factor in tribal life, particularly as being the prototype of the council of the city-state, which, as already remarked, only reproduces on a larger scale the relations of the previous stage of society.

In limiting the *ἀγχιστεία* to the degree of great-grandson, Mr. Seebohm seems to be quite right, although there are authorities who interpret *παῖδες* in the crucial expression *ἀνεψιῶν παῖδες* as meaning not merely children, but descendants. The evidence afforded by the litigation between the members of the family of Bouselos, which is excellently described on pp. 62 *ff.*, seems to make this clear.

The closeness of family relations in Greece gave rise to a curious state of things as regards the position of the illegitimate child. The position of the *νόθος* is perhaps not quite clearly stated by Mr. Seebohm. In one sense he had no place in the kindred. He could not be admitted to the phratria without the consent of the true son. The laws of Solon allowed no right of inheritance to the bastard, except in the case of failure of legitimate heirs. (It is true that the scholiast on the

passage of Aristophanes where this law is quoted thinks it is an invention of the poet's. But in any case the invention was probably founded on fact). In the text of the speech of Demosthenes against Makartatos is a law dating from Eukleides (403 B.C.), which seems to refuse to bastards even the limited right granted by Solon, as nothing is said of the case of legitimate children failing. But it is unwise to press the interpretation of the laws quoted in the speeches of Demosthenes, as they are notoriously in most cases interpolations of a later date. In any case it is clear that under ordinary circumstances the bastard could not be ἀγχιστής in his father's family. He could only claim as inheritance the νοθεῖα, which was a very limited sum. But this must not be interpreted in the sense that he was altogether an outcast. Politically he suffered little. Gilbert ("Greek Constitutional Antiquities," Eng. trans. p. 191, note 1) believes that νόθοι *ex cive Attica* were *ipso facto* citizens. When both parents were citizens, the bastard would probably belong to the Phyle of his mother, and when of age would be admitted to her Deme. The position of the bastard, however, brought into play the same device for evading the law as that suggested by our new death-duties, and wealth, as the scholiast already quoted informs us, was made over by the father by gift before his death. Greek society thus did something to alleviate the lot of the illegitimate son, whose position in the family, or rather out of it, might otherwise have been somewhat hard.

Mr. Seebohm is nervous lest, in ascribing to the structure of Athenian society a direct parentage amongst tribal institutions, he should meet with considerable criticism. It is improbable that any one will dispute his main conclusions. At any rate he is sensible of most of the difficulties attaching to his subject. There are many features in Greek society which seem foreign to the tribal system. The absence of Homeric evidence for regular ancestor-worship is not very satisfactorily explained by the suggestion that "the aristocratic tone of the poet did not permit him to bear witness to the intercourse with any deity besides the one great family of Olympic gods, less venerable than a river or other personification of nature." The Homeric poems, especially the Odyssey, are too full of the small details of daily life to permit us to accept this explanation—for Homer deals with swineherds as well as kings. Or take, again, the question of burial. De Coulanges ("La Cité Antique," p. 68) states roundly that the ancient custom was to bury the dead, not in cemeteries or by the way-side, but in the field belonging to each family. He adduces evidence for the survival of this custom even in the time of Demosthenes. But if this was the rule, what are we to say of the innumerable cemeteries dating from all periods, prehistoric downwards, which have been discovered all over Greece and on the islands and shores of the Aegean? In some parts, such as Lycia, we find the true tribal system of burial in use down to late times; but it is hardly an exaggeration to say that this is exceptional.

The essay before us touches on several questions of this kind, but space doubtless prevented the author from dealing with them at greater length. It is to be hoped that he will continue this line of study, and produce the volume dealing with Roman customs to which he alludes in his preface.

G. F. HILL.

A BIOLOGIST AS METAPHYSICIAN.

Mind and Motion and Monism. By the late George John Romanes, M.A., LL.D., F.R.S. Pp. vii. + 170. (London: Longmans, 1895.)

THIS little volume of Mr. Romanes' metaphysical writings possesses great interest. The type of philosophical theory which he represents has a singular fascination. He himself, it is plain, possessed genuine metaphysical powers, and he wrote at first hand, and with the acuteness and freshness of mind which are worth more than much learning. At the same time, he suffers for his disengagement from the work of other philosophers. The *naïveté* which forms the opening sentence of the book, that Hobbes is "the earliest writer who deserves to be called a psychologist," is a trifle. But there is no evidence that he had studied the father of monists, Spinoza; and though some points in his essay might have been modified if he had lived, it presents difficulties which, to a student of Spinoza, seem to be of the first magnitude. Yet, like the rest of his philosophical writing, even when it is unsatisfactory (and it seems to us unsatisfactory), it stimulates thought.

The volume consists of two essays, the Rede Lecture of 1885 on Mind and Motion, and a longer treatise on Monism, which amplifies and expounds the metaphysical ideas of the earlier essay, but makes many additions. Romanes holds with Clifford (who seems to have inspired his speculative thinking) that wherever there is matter there is mind in some form or other, and that mind and matter are everywhere but two aspects (two modes of apprehension he calls them) of one and the same reality. He makes admirably clear the truth that a physiological process which is accompanied by consciousness would not be what it is, if it were unaccompanied by consciousness, any more than we can separate the light and heat of an Edison burner. He shows that if we apply the idea of causality to mental action, we must apply it to the twofold reality, which is both physical and mental. But he throws no light on the difficulties raised by the phenomena of so-called unconsciousness. His disproof of spiritualism, as implying a creation of energy, is satisfactory; his disproof of materialism is less so. It is a shorter way with the materialists than even Berkeley's. To treat mind as a function of matter would be to treat it as a function of itself, since all that we know of the external world is our own mental modifications. Whereas Berkeley held matter to have no existence, save as an object of mind, Romanes goes further, and regards it as in some way mind itself. But if one fact is clearer than another, it is that we rarely have knowledge of our mental states, and that we primarily know objects. On the other hand, the simpler solution, that a physical process which is accompanied by consciousness cannot be merely physical, would afford no foundation for the theory of monism.

The most interesting portions of the essay are those in which he goes beyond Clifford. Clifford had stopped with attributing to each part of matter some portion of mind, mind-stuff, but said nothing of the universe itself. Romanes holds that we may regard the whole world of objects as itself an eject (*i.e.* an inferred subject), which we may regard as super-conscious. He founds himself on

the idea of a social consciousness working in the minds of members of a society. Though in his idea of an absolute mind he approaches most nearly to Spinoza, the argument is totally different, and the difficulties it raises are overwhelming. Is such a mind finite or infinite? If finite, where are the bounds of matter? If infinite, the analogy from the minds we know, which accompany a limited portion of matter, breaks down. Of a social mind we know nothing in fact; but so far as we conceive it clearly, we conceive it as animating the minds of individual persons. Yet if it is to supply a basis of inference to an absolute mind which animates the whole universe of physical and material things, we must suppose it to animate not merely ourselves, but our houses and all the material of our social life.

Romanes' thought reaches its highest flight where he identifies the principle of causality with volition. By this means he seeks to maintain the freedom of the will, and to find an explanation of morality and responsibility. It is an argument of much subtlety and ingenuity, in which elements are blended that remind us partly of Kant, partly of Green, but never of Spinoza. It culminates in an interesting theistic speculation, in which the absolute will is represented as assenting to the free volitions of all relative wills. The basis of the argument is a protest against regarding causality as in any sense prior to the mind, so that the mind should be subject to determination. The consciousness of causality is derived from volition, and therefore, so he seems to argue, volition is the primary cause. Hence the will as will is free to will anything whatever, even the impossible—it is limited only in its executive capacity through the restraints imposed on the body. On the other hand, though every will is free and might have willed otherwise, the moral or rational will is that which wills what is expedient under the circumstances in which actions have to be performed in the external world. This is no restriction of freedom, any more than a man is not free to marry, because to do so he must go through the marriage ceremony (a strange re-emergence this of the notion that moral action is simply self-consistent action). The questions raised by the argument are seductive. Every reason which Romanes alleges for the freedom of mind, as unaffected by causality, is equally an argument on the monistic theory against the causal necessity to which matter, he believes, is still subject. Instead of holding mind free and matter bond, he should have held them both equally bond or equally free, or should have declared causality to be an illusion. As it is, he has in reality reintroduced the notion of a mind which is not even affected by its own character. And this on the ground of what seems to be a confusion between two interpretations of will, as the process of which we are aware in volition, or as some supposed activity behind volition itself. If causation and volition are identical, as he says, and we become aware of causation by volition, the will must be the process known. But this may surely be subject to causality, like any other object of thought. If the will is understood in the other sense, how are we to understand the monistic identity of mental state and physiological process? Elsewhere Romanes urges that the mind is free, since whatever acts upon it is recognised by it as a motive. It would seem then natural to hold that while minds as well as bodies must be regarded as subject to determination, i is only minds which are conscious of their motives, an which therefore may have the consciousness of freedom.

S. A.

OUR BOOK SHELF.

Farm Foods: or, the Rational Feeding of Farm Animals. By Emil v. Wolff. Translated by Herbert H. Cousins, M.A. Pp. xvi. + 365. (London: Gurney and Jackson, 1895.)

This is a translation from the sixth edition of the well-known "Landwirtschaftliche Fütterungslehre" of Prof. v. Wolff, of Hohenheim. The book embraces three sections, dealing severally with the general laws of animal nutrition, the food of farm animals, and the feeding of farm animals. The most valuable part of the volume is the appendix which consists of a series of six tables relating to (1) the average composition and digestibility of farm foods; (2) the digestibility of food-stuffs; (3) the nitrogen of foods expressed as albuminoids and amides; (4) feeding-stuffs for farm animals; (5) percentage composition of different parts of oxen, sheep, and pigs; (6) composition of carcase of oxen, sheep, and pigs. It is a coincidence that the volume should have appeared at about the time when the plaint went up at the meeting of the British Association at Ipswich, that for purposes of teaching or calculation we have to employ the results of German analyses relating to crops and food grown in a different climate, and under different conditions, from our own. In this way expression was given to the fact that the essential parts of Wolff's tables could be found in English books any time within the last eighteen or twenty years, so that agricultural students who were unable to read Wolff's work in the original were, nevertheless, not greatly handicapped. The circumstance that Wolff's investigations have in this way been so thoroughly "exploited" by English writers will no doubt impair the freshness and originality such as would have been associated with a translation of the treatise when it first appeared in 1874.

The examples that are given have a distinctly Teutonic flavour, and we may be pardoned for saying that, from our standpoint, they are somewhat academical. English farmers know nothing, for example, of potato slump, and Scotch farmers have to fatten their bullocks without mangel. Yet German beef is not to be mentioned in the same breath as the prime juicy joints of British growth, and German farmers have yet to bring their practice up to the level of turning out finished steers at three years old. A problem of far greater interest than any of those discussed would have been: Given a breeding flock of 500 or 1000 ewes to carry through such a season as either of the last two winters in Great Britain, with frosts severe and forage scarce, how would it best be done? English sheep-breeders solved this problem, and if they study this volume they will without doubt give due weight to the words (p. 105): "it is evident that our methods for the chemical analysis of food-stuffs, as well as our knowledge of the peculiar properties and proportions of different food-constituents, leave much to be desired."

The translator has done his work carefully, but he is not happy in his prefatory remarks, which show a lack of familiarity with English agricultural literature. When he refers to "the rather obtrusive fact that the book is simply the record of forty-two years' work by the experimental stations of the German Government on the feeding of farm animals," and further on says that "perhaps the most valuable feature of the book is that of the tables given in the appendix," he apparently overlooks the circumstance that at least two of the six tables are, as is acknowledged by Wolff himself, based principally on the results of Lawes and Gilbert, as published in the *Philosophical Transactions* in 1859 and 1883. But the reader will be prepared to overlook much when he sees

that even the name of Rothamsted is misspelt, both in the text and in the index. That Wolff's work, in English dress, will serve to increase the fame of its author cannot for a moment be doubted, and it is much to be hoped that many of the intelligent readers into whose hands it may fall will be qualified to read the volume critically.

Dog Stories from the "Spectator." With an Introduction by J. St. Loe Strachey. Pp. 264. (London: T. Fisher Unwin, 1895.)

A FEW of these stories record reasonable and well-observed instances of intelligent and deliberate acts of dogs, but most of them are anecdotes in which a modicum of fact is lost in a plenum of anthropomorphic fancies.

When an animal does anything remarkable, the average man (and more so the average woman) conceives that it is guided to its action by a train of *human* reasoning. It must, of course, be granted that dogs often behave with exceptional intelligence, and perform acts with distinct ends in view; we do not, indeed, venture to doubt any of these stories from the correspondence columns of the *Spectator*. But few people seem to be able to separate the "what" from the "why" when writing of animals' actions. Well-authenticated and trustworthy notes on canine intelligence are valuable; but when the narrators essay to explain the dog's motives, they get out of their depth. Here is the gist of a story of this kind: A dog jumped into a carriage at one of the stations on the District Railway; it remained under a seat of the compartment when the train stopped at two stations while the carriage door was opened, but when the door was opened the third time, the dog jumped out and slunk away. There is no evidence whatever that the dog's act was deliberate; and unless there were proofs to the contrary, it must be assumed that it was simply the result of impulse. Yet the anecdote fills nearly two pages of the book, the writer assuming that the dog recognised the station at which it alighted, and concluding with the words: "I suppose that he had been transferred to a new home, which had proved uncongenial, and was slipping away, in fear and trembling, to his old quarters." This is a fair example of the sentimental type of dog story—a type which predominates in the collection before us. A man who knows how to observe in a scientific manner, has no patience with the crude statements and unsupported assertions which make up most of these epistles; he will put his finger on weak points in nearly every page of this book. Many of the facts are the results of coincidences, but here and there among the chaff will be found grains of information of real importance to students of the instincts and habits of animals. The value of the stories is largely discounted from the scientific point of view, by the fact that the writers are often anonymous.

Science Readers. By Vincent T. Murché. Books v. and vi. (London: Macmillan and Co., 1895.)

THESE books are intended to be read by pupils in elementary schools, in conjunction with "object-lessons" given by the teacher. The text has been so carefully prepared, that juvenile readers will have no difficulty in understanding it, while the profuse illustrations add to its attractiveness. The apparently indiscriminate distribution of the subjects of the reading lessons is not one that commends itself to those who regard the orderly statement of facts as the cardinal principle of scientific instruction; but it must be remembered that pupils have to be interested as well as instructed, and Mr. Murché's practical knowledge of what interests the young people for whom he writes, has led him to depart from a strictly scientific arrangement. Putting this aside, however, the books contain a large amount of useful information, which the elementary scholars who read them will easily acquire.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The November Meteors.

FROM various observations it would appear that the Leonids have not presented any unusual activity this year. The weather was tolerably favourable on the nights of November 12, 13 and 14, though there were occasional clouds and showers of rain; meteors were not, however, particularly numerous at any time.

At Bridgwater, on November 12, Mr. Corder watched the sky during the period from 14h. 5m. to 16h. 30m., and observed eighteen meteors, of which three or four only were Leonids.

At Bristol, on November 13, the writer counted ten meteors between 11h. and 13h. 30m., of which two only were Leonids. The sky was, however, partly overcast. At Bridgwater Mr. Corder maintained a look-out between 14h. and 16h. 10m., and recorded twenty-six ↙'s, including eleven Leonids with a well-defined radiant at $152° + 23°$.

At Bristol, on November 14, the writer saw very few meteors, and no Leonids before midnight. The observations were, therefore, relinquished as not likely to be productive.

During the nights following the 12th and 13th, and on the early part of that of the 14th, it is certain, from the above notes, that the Leonids were not numerously visible. If, therefore, the earth passed through a region of the stream much denser than usual, the *rencontre* must have occurred during daylight on the 14th. Observations in America will probably allow this point to be determined.

One of the best of the mid-November meteor showers has its radiant in Taurus, and it is a stream which furnishes an unusual proportion of fireballs. Several of them have been observed in the present year. About ten Taurids were seen at Bristol on the nights of the 13th and 14th, and Mr. Corder says that on the 12th and 13th he found them rather active and diverging from an accurately marked centre at $58° + 22\frac{1}{2}°$.

Fireballs appeared on November 9 at about 8h. and 10h. 45m. p.m., and on November 11 at 6h. 2m. p.m. Several conspicuous meteors were also remarked on the early evening of November 14. W. F. DENNING.

Bristol, November 17.

P.S.—A communication just received from Dr. A. Riggenbach, Professor of Astronomy at the University of Basle, Switzerland, contains the following:—"On November 13, after heavy rains the sky cleared up, and during the hours from 9h. 40m. to 13h. I perceived fourteen meteors, but only two of them appeared to be in connection with the Leonid swarm. From 1h. in the morning of the 14th, clouds impeded the observations. On November 14–15 the sky was overcast." Dr. Riggenbach's experience would therefore appear to corroborate the meagre results obtained at Bridgwater and Bristol.—W. F. D.

A Remarkable Daylight Meteor.

JUST before five in the afternoon of Wednesday, the 13th inst., a meteor of rare brilliancy, evidently one of the Leonids, was seen here. It was as large as Venus at its best. When flashing into view it lighted up the landscape with startling effect, though daylight had not faded. The meteor was followed by a dazzling golden-coloured train, which lasted for several seconds. The colour of the meteor by the waning daylight was of a peculiar greenish-blue tint.

Owing to the large size and intense brilliancy of the meteor, I expected that its grand appearance would have been observed in some other locality and noted in NATURE. Here this season the stream of the Leonids has been little in evidence.

Worcester. J. LLOYD BOZWARD.

The Feeding-Ground of the Herring.

IN your issue of October 24, Mr. Alexander Turbyne takes exception to the belief that copepods are most abundant between the Laminarian zone and the 20-fathom line. He gives his experience to prove that they congregate chiefly "in the deep water over the mud," and his contention is that herrings found with great numbers of copepods in their stomachs feed, for the

most part, at considerable depths, as in the depressions of 70 to 90 fathoms found in Loch Fyne.

I notice that this letter has now been reported in the *Fish Trades Gazette*, and, fearing lest the statement should go further unchallenged, I should like to suggest that the experiences of Brady, Herdman, and Scott cannot be set aside lightly. I in no way doubt the statement that copepods are abundant on the mud at 70 fathoms, but from the evidence given it is surely unnecessary to conclude that such depths are the natural feeding-ground of the herring. In Loch Fyne, after continued calms, I have seen congregations of *Calanus finmarchicus* floating in belts of dull opaque yellow, or left by the tide in such masses as made it possible to scoop them up in one's hand. It is far from probable, I fancy, that Mr. Turbyne's deep-water forms were more abundant, and yet the question is not merely one of the vertical range of copepoda. That herrings descend to a considerable depth seems true. That their eggs will hatch at as great a depth of 95 fathoms, the late Mr. George Brook and I proved in Loch Fyne. If at certain seasons they tend to congregate in deep areas, it is fortunate that, as Mr. Turbyne shows, a favourite food is to be had; yet when the copepods were as I describe, I saw the herrings being caught near the surface—I spent many nights off Skippness Point and in Kilbrennan Sound—and the fishermen told me that beneath such floating belts of copepods, closely packed shoals are usually to be met with. The fishes taken were gorged with *Calanus* and a few other species, such as *Temora longicornis* and *Dias longiremis*. The so-called disease of gut-pock was then prevalent. This I attributed, rightly or wrongly, to excess of oil brought into the intestinal tract by the copepods. The oil extruded plentifully from the anal openings. This, then, is evidence of herrings feeding freely on a plethora of copepods near or on the surface; evidence of a similar kind to that of Mr. Turbyne's, yet with an opposite deduction.

W. L. CALDERWOOD.

Napier-road, Edinburgh, November 11.

MacCullagh's Theory of Double Refraction.

IT is quite clear that Mr. Larmor has misapprehended the purport and object of the criticisms in my letter to NATURE of October 3.

I have not attempted to discuss the question whether or not "a gyrostatic ether may be constructed which will function (*sic*) according to MacCullagh's optical scheme." What I have said, is that the theory advocated by Mr. Larmor violates the principle of angular momentum, which is a totally different thing. I have also carefully avoided making use of any such phrases as "ordinary elastic matter," "elastic solid matter," and the like; for the employment of such expressions with reference to a quasi-fluid medium of extreme rarity, such as the ether is supposed to be, is altogether misleading, and is responsible for a good deal of misconception upon the subject.

Ever since the undulatory theory was accepted by the scientific world, the object of mathematicians has been to endeavour to form a conception of a medium whose properties are such, that optical phenomena may be deduced therefrom by dynamical principles and methods; and in order that any attempts should be successful, it is necessary for the medium to possess inertia, and also to be capable of resisting deformation. The latter condition requires that the forces on any right solid element, which are due to the action of contiguous parts of the medium, should consist of nine stresses. Now, whatever physical properties we may ascribe to the ether, or whatever the mathematical form of the equations may be which connect the nine stresses with the quantities upon which deformation depends, the principle of angular momentum requires that three relations should exist between the six conjugate stresses, except in the two special cases I have referred to in my former letter; that is to say, unless the medium is a gyrostatic one, or unless it is under the action of some system of forces (mutual or otherwise) whose action upon an element consists of a couple as well as a force.

Mr. Larmor appears to think that a satisfactory solution can be obtained by postulating an energy function, and deducing the equations of motion and the boundary conditions by the principle of least action; but this view is fallacious. For if some particular form of the energy function were assumed, and were found to lead to results which violate the principle of angular momentum, the theory would be dynamically unsound, and the results would represent some impossible form of motion. To write down certain mathematical expressions, and to perform certain mathematical operations, do not constitute a satisfactory theory, unless it can be shown that all the results furnish a consistent scheme in which none of the fundamental principles of dynamics are violated.

Mr. Larmor also suggests that possibly the energy function of a gyrostatic medium might be modified[1] in such a manner that MacCullagh's equations might be deduced therefrom by means of the principle of least action, and that it would be interesting and instructive to establish this in detail. But why has this not been done? If a mathematical investigation of this kind would be unsuitable for NATURE, the same objection would certainly not apply to the *Philosophical Transactions*.

I shall defer entering fully into the subject of magnetic action on the present occasion; but in the paragraph marked (2), Mr. Larmor has altogether failed to deal with the objection which I advanced, viz. that his theory is open to exactly the same defect as my own, inasmuch as it makes the tangential component of the E.M.F. discontinuous at an interface. What, according to Mr. Larmor's view, is the mathematical expression for the E.M.F. in a magnetised medium? What is the physical interpretation of the boundary condition referred to in my second letter? Does he propose to modify Maxwell's equations connecting the E.M.F. with the electric displacement? If he does, he ought to have stated the fact, explained the nature of the modifications he proposes, and his reasons for adopting them.

In conclusion, I fail to see that Mr. Larmor has made any adequate reply to my criticisms. To do this he must show (1) that his resuscitation of MacCullagh's theory does not violate the principle of angular momentum; (2) that his magnetic theory makes the tangential component of the E.M.F. continuous at an interface.

A. B. BASSET.

Fledborough Hall, Holyport, Berks, November 12.

1 The theory of the mixed transformation of Lagrange's equations, which leads to the energy function alluded to, was first given by myself in 1887. (See *Proc. Camb. Phil. Soc.*, vol. vi. p. 117, and "Hydrodynamics," vol. i. p. 173.)

The Nomenclature of Colours.

THE letter of Mr. Herbert Spencer in your issue of August 29, suggesting the use of a nomenclature to be used in connection with a scheme of colour standards, on a plan similar to that used by sailors in boxing the compass, is interesting, both because of its obvious appropriateness and because, as Mr. Spencer suggests may be the case, it has occurred to others. In a paper read before the American Association in 1890, I suggested the same idea, but at the same time stated that this would probably give more hues between the six standards than would be convenient in view of the uncertainty that will almost surely result in the mind of the common observer as to just which term should be applied in any one particular case. In view of this, I thought it wise to make the number of hues between the standards smaller than the compass chart would give. Those who have applied the standard colours to educational work have found this desirable.

The Milton Bradley Company, in their educational series of colour papers, have introduced only two hues between the standards. This makes the series R OR RO O YO OY Y GY YG G, &c. Mr. Louis Prang, of Boston, some two years since published a small pamphlet, proposing to make the series for common use R RRO ORO O OYO YO YYO Y, &c. On the whole, I think it wise to adopt the smaller number for ordinary use, and interpolate others for more delicate discriminations. A plan which seems to me a very practical one is the following, in which the hues represented by the symbols in capitals are for ordinary use, and those in small type for more careful discrimination: R orr ror OR oor rro RO oro roo O yoo oyo YO yyo ooy OY yoy oyy Y, &c. Translated into words, this would be RED, orange-red red, red orange-red, ORANGE RED, orange orange-red, red red-orange, RED ORANGE, orange red-orange, ORANGE, &c. Whatever method is used, however, does not in any way affect the value of the scheme of definitely determined standards of colour as proposed in my paper.

J. H. PILLSBURY.

Stoneham, Mass., U.S.A., November 7.

THE *Scientific American*, of New York City, in its issue of October 19, 1895, quotes from a letter to NATURE (vol. lii. p. 413), written by Mr. Herbert Spencer, suggesting that a

system of colour nomenclature might be devised by indicating colours in a manner analogous to the accepted nomenclature of the points of the compass.

In this connection the enclosed circular, published by me during the summer of 1893, to explain briefly my system of colour standards, may be of interest to your readers. You will see that the system of colour nomemclature here described corresponds almost precisely to the idea in Mr. Spencer's mind.

October 24. LOUIS PRANG.

[WE have received, with Mr. Prang's letter, the circular descriptive of his system, which is essentially the same as that suggested by Mr. Spencer. As Mr. Spencer pointed out in his letter to us, the idea is a very obvious one, and had probably occurred to others; but this does not, of course, diminish its value. For ourselves, we are glad to see that the idea has been put into practice, and that, out of a chaos of colour-names, an intelligent system of nomenclature has been evolved. A series of standard coloured papers, harmoniously bound together, is published by the Prang Educational Company, Boston, for the use of teachers, designers, artists, and others.—ED. NATURE.]

RECENT IMPROVEMENTS IN LIGHTHOUSE ILLUMINATION.

PRIOR to the year 1822, the optical apparatus used in the best equipped lighthouses was silver-plated parabolic reflectors, having apertures, twenty-one inches for fixed, and twenty-five inches for revolving lights, their focal distance being four inches. These instruments, with a burner one inch diameter, and an initial power of eleven candles, condensed the light into a beam of 1304 and 2360 candles respectively. The power of a first order reflector light of sixteen reflectors, ranged on a frame having four faces, was equal to 9340 candles. These were the instruments (Fig. 1) which A. Fresnel,

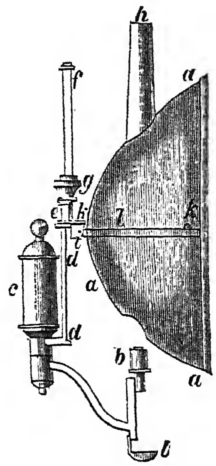


FIG. 1.

the celebrated physicist, replaced by optical apparatus of glass lenses and prisms acting by refraction and reflection in combination with a central lamp and multiple-wick burner of considerable power. In doing so he devised four optical agents: the annular lens, totally reflecting prisms, the cylindric refractor for small apparatus, and straight vertical reflecting prisms. These instruments he combined in different ways to form fixed and revolving apparatus suitable for lighthouse purposes. The annular lens subtended at the focus 45° vertically and horizontally, the focal distance being 920 m.m. (36·22 inches). Some of Fresnel's optical instruments in the hands of Mr. Alan Stevenson, underwent very notable alteration, extension, and improvement. The first order lens was extended to subtend 57° vertically, and reflecting prismatic rings were substituted below the lenses for silvered mirrors. The central portion of the first order fixed light apparatus (Fig. 2) was converted from a polygon formed of narrow lenses to a cylindrical drum, which drum was divided into sections having helical joints, and above and below the central belt reflecting prisms were introduced.

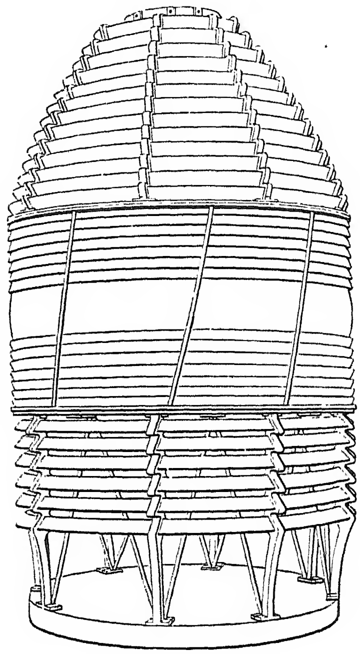


FIG. 2.

The next improvements were those of 1849–1850, by Mr. Thomas Stevenson, the main feature of which was that, for revolving lights, totally reflecting prisms generated round a horizontal axis were introduced above and below the lenses, lenticular action being thus extended throughout the whole height of the instrument (Fig. 3).

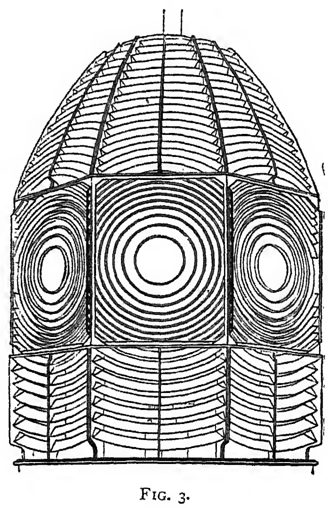


FIG. 3.

Then followed the dioptric spherical mirror, the dioptric holophote, the azimuthal condensing system, and its application to fixed, flashing, intermittent, and group flashing lights; the bivalve apparatus of 1859, which is really two holophotes ten feet in diameter, increased in power by a dioptric mirror, and numerous combinations of these and previously devised instruments.

One of the most notable of recent improvements is the hyper-radiant apparatus of 1330 m.m. or even greater radius, proposed by Messrs. Stevenson in 1869 (Fig. 4). This apparatus was designed to take advantage of the large and powerful flames of burners of greater diameter than five-wick; the introduction of burners of increased size having been inaugurated by Mr. Wigham in connection with his gas burners, and rendered possible, on financial grounds, with oil burners, by the introduction of paraffin. With revolving apparatus of 920 m.m. radius, it was clearly demonstrated that with burners of large diameter, much of the light, being exfocal, escaped condensation, and hence the hyper-radiant apparatus was designed to utilise and condense the rays proceeding from the large radiant. The light from one of the lenses of a hyper-radiant apparatus is more intense with the same size of burner in the focus than that from two lenses of 920 m.m. The hyper-radiant is now largely used by all lighthouse authorities. In 1872, Mr. Wigham suggested a very obvious method of increasing the power of a lighthouse by superposing in the lantern two, three, or four lenses, each with its own burner. Such arrangements have been introduced at several lighthouses, both in Ireland and England, but it is difficult to see what the advantage is, as it is quite easy with a single apparatus, properly designed, and single burner to get the same power and at a less cost. Mr. Charles A. Stevenson designed a form of refractor which is spherical in the horizontal and vertical planes, and this form was adopted in the apparatus of North Fair Isle lighthouse. The spherical refractor, if it has spherical profiles, loses in efficiency if carried beyond an angle subtending 20° at the focus, but when this design has combined with it Mr. C. A. Stevenson's equiangular prisms, as in the design for Sule Skerry lighthouse, there is less divergence, and hence less loss of light, than is the case with the Fresnel forms; in the case of the spherical lens, from the fact of its greater radius, and in the equiangular, from the prisms being of profiles of minimum divergence for exfocal light. In the design for Rattray Head apparatus, the equiangular prisms have been adopted to enable the lens to be carried to 80° of a vertical angle, the prisms at this high angle of refraction still remaining of good efficiency; whereas when lenses are carried to this high refracting angle by Fresnel's prisms, the lenses become very ineffective, owing to their great divergence for exfocal light. In recent designs by Messrs. Stevenson, of optical apparatus for New Zealand, lenses equiangular throughout have been introduced (Fig. 5).

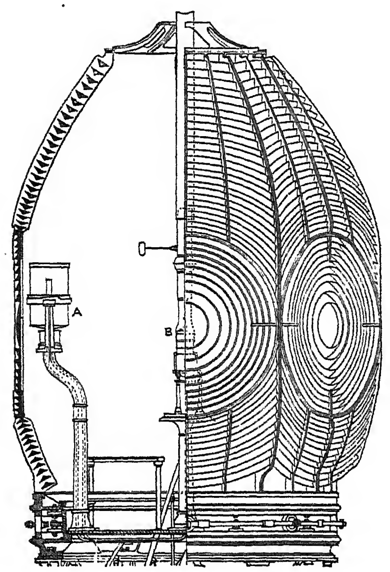
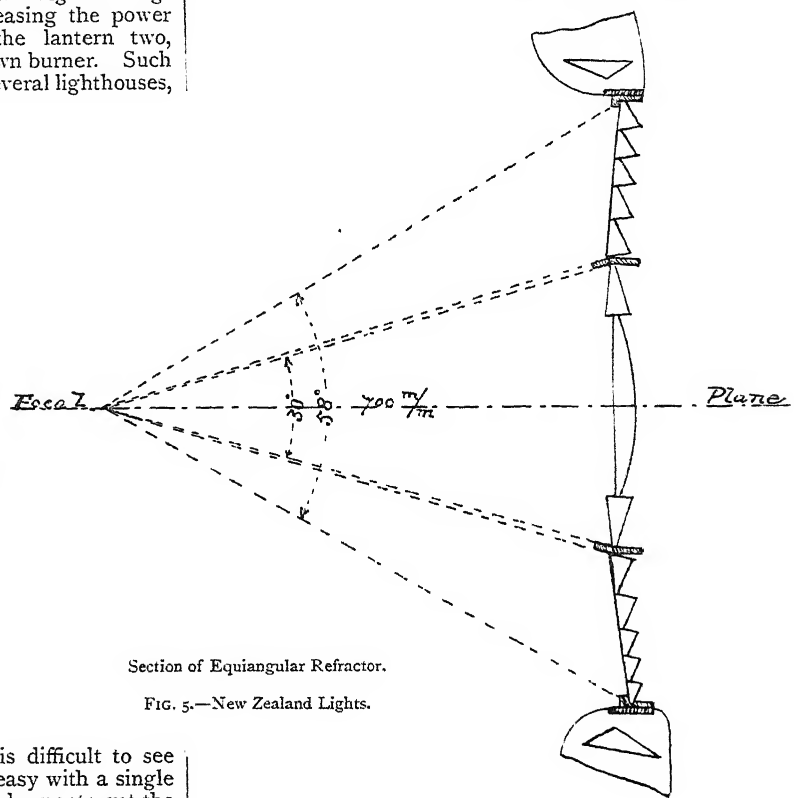


FIG. 4.



Section of Equiangular Refractor.

FIG. 5.—New Zealand Lights.

The increased and ever-increasing speed of steamships has necessitated the adoption, for over-sea and prominent lighthouses, of revolving, flashing, and group flashing apparatus, having short periods of light and darkness. This is desirable in order that the sailor may be able, in a short space of time, without appeal to a watch, to tell the character of the light he sees. But long before the days of fast steamers, Mr. R. Stevenson recognised the desirability of shortening the periods of light and darkness, and in 1825 he introduced the "flashing" distinction on the coast of Scotland, having periods of 5″ light and 5″ darkness. Subsequent experience has fully proved the utility of this striking characteristic. In 1874, Dr. Hopkinson proposed the important group flashing characteristic, which has since been largely adopted.

The length of the duration of a flash to be effective has been lately much discussed by lighthouse engineers and is a matter of great importance, for the shorter the flash can be made with efficiency, the stronger it can be made. Messrs. Stevenson have, in recent years, been gradually reducing the length of the flashes in apparatus designed by them, and in the case of the Isle of May electric light, installed in 1886, they reduced the flashes to half-second duration. They have not been followed in this by the lighthouse engineers of other countries, as, for example, in the case of St. Catherine's, lighted in 1888, where the flashes are 5″ duration. The French lighthouse engineers, however, have gone further, and within the last two years have designed lights, the duration of the flashes being only one-tenth second. This is going to the other extreme. M. Bourdelles and M. Blondel, in papers read before the International Maritime Congress, 1893, give the grounds on which they advocate such short flashes. They say, and say

truly, that physically even less than one-tenth second is sufficient to make the maximum impression on the eye, and conclude that a longer duration is therefore unnecessary. This would be a sound conclusion were the atmosphere always clear, but it is not so. Now it is physically true, as they admit, that the duration necessary for the full effect of a flash depends on the intensity of the light; a weaker flash must have a longer duration than a stronger one, to make the full effect on the retina. But by the time a powerful flash has pierced a few miles of hazy atmosphere, it is no longer powerful, and if it has not a duration suitable to its reduced power, it will not be seen so far. This is a question which cannot be settled on merely theoretical grounds, but must inevitably be a matter of experience. The following are a few figures showing the great power of some modern lighthouse apparatus now in use in the Trinity House and Northern Lighthouse Services, as compared with anything employed during the days of colza oil, fixed lights, and apparatus of many sides.

The Isle of May light has a calculated intensity of no less than 26,000,000 candles to each flash, while the St. Catherine's electric light, calculated on the same basis, has a strength of beam equal to 5,000,000 candles. The power of the La Heve electric light is stated at 23,000,000 candles.

Turning now to the ordinary lights, where paraffin oil is the illuminant, the following may be mentioned as being of very great power. The Bishop Rock, biform, with two eight-wick burners and hyper-radiant apparatus, gives a flash of 175,000 candles. The Eddystone, with two six-wick burners and first order apparatus, gives a flash of 75,000 candles. Sule Skerry, with one six-wick burner and hyper-radiant apparatus, gives a flash of 74,000 candles, and Fair Isle North, one six-wick burner and hyper-radiant apparatus, without upper and lower prisms, gives a flash of 72,000-candle power.

The result of recent improvements in the optical apparatus used in lighthouses, and in the increased power of the lamps, is that the mariner is now getting the benefit of lights of greater intensity and more characteristic appearance, easily and rapidly recognisable.

THE DEPARTMENT OF ENTOMOLOGY IN THE U.S. NATIONAL MUSEUM.

The staff of the Department of Insects of the U.S. National Museum has been reorganised, as a result of the death of the former Honorary Curator, Prof. C. V. Riley.

The reorganisation has been effected by the appointment of Mr. L. O. Howard, Entomologist of the U.S. Department of Agriculture, to the position of Honorary Curator of the Department of Insects; of Mr. Wm. H. Ashmead to the position of Custodian of Hymenoptera; and Mr. D. W. Coquillett to the position of Custodian of Diptera. All Museum custodians are honorary officers. Mr. M. L. Linell will remain as general assistant to the Honorary Curator.

The Department is at present in excellent working condition. It contains a very great amount of material in all orders, and in many unusual directions surpasses any collection in the United States. Among others, the following are of especial interest:—

(1) The large collection, in all orders, of the late Prof. C. V. Riley.

(2) All of the material gathered during the past eighteen years by correspondents, field agents, and the office staff of the Division of Entomology, U.S. Department of Agriculture.

(3) The greater part of the collection of the late Asa Fitch.

(4) The large collection, in all orders, of the late G W. Belfrage.

(5) The collections in Lepidoptera and Coleoptera made by Dr. John B. Smith down to 1889, together with the types of the Noctuidæ since described by Dr. Smith.

(6) The collection of Lepidoptera of the late O. Meske.

(7) The collection of Lepidoptera of G. Beyer.

(8) The collection of Coleoptera of M. L. Linell.

(9) The bulk of the collection, in all orders, of the late H. K. Morrison.

(10) The collection of Diptera of the late Edward Burgess.

(11) The type collection of Syrphidæ made by Dr. S. W. Williston.

(12) The collection of Ixodidæ of the late Dr. George Marx.

(13) The collection of Myriopoda of the late C. H. Bollman.

(14) Sets of the Neo-tropical collections of Herbert Smith.

(15) The collection of Hymenoptera of Wm. J. Fox.

(16) The collection of Tineina of Wm. Beutenmuller.

(17) The large Japanese collection, in all orders, of Dr. K. Mitsukuri.

(18) The African collections, in all orders, of Dr. W. S. Abbott, Wm. Astor Chanler, J. F. Brady, the last "Eclipse" expedition to West Africa, and of several missionaries.

(19) The large collection from South California of D. W. Coquillett, in Coleoptera, Hymenoptera, Lepidoptera and Orthoptera.

(20) The Townend Glover manuscripts and plates.

In addition to this material, there are minor collections which have been the result of the work of Government expeditions, or are gifts from United States Consuls and many private individuals.

This enormous mass of material is being cared for by the active and honorary force of the Department, and the perpetuity of the collection is assured. The National Museum building is fireproof, and this, together with the fact that it is a National institution, renders the Department of Insects, perhaps, the best place in the United States for the permanent deposit of types by working specialists in entomology, and for the ultimate resting-place of large collections made by individuals.

The policy of the Museum at large, with regard to the use of its collections by students, is a broad and liberal one. Students are welcome in all departments, and every facility is given to systematists of recognised standing.

NOTES.

It is proposed by the Administrative Council of the Pasteur Institute to make an international appeal for subscriptions to erect a monument to the memory of Pasteur.

An ordinary meeting of the Royal Society, for the reading of papers though not announced upon the printed list of arranged meetings, will be held on the 28th inst.

Sir Archibald Geikie and Prof. Story Maskelyne have been elected corresponding members of the Munich Academy of Sciences, in the Mathematical and Physical Section; and Dr. H. B. Swete, of Cambridge, has been elected a corresponding member in the Philosophical and Philological Section of the same Academy.

In accordance with the arrangement mentioned in our last week's issue, Dr. A. G. Butler becomes Senior Assistant-Keeper of the Zoological Department of the British Museum, with special charge of the section of insects, and Mr. Edgar A. Smith and Dr. R. Bowdler Sharpe have been promoted to fill the two other assistant-keeperships. Mr. Vernon Herbert Blackman, of St. John's College, Cambridge, has been appointed, after competitive examination, an assistant in the Department of Botany, in the place rendered vacant by the promotions consequent upon the retirement of Mr. Carruthers.

WITH reference to the aurora briefly noted in our last number (p. 35), Mr. J. Shaw writes from Tynron, Dumfriesshire, as follows:—"At 11 p.m. November 9, I saw an aurora extending from the north-west to the north-east, where it began to break into long lines, one line lying above the planet Jupiter. It occupied about one-fourth of the distance from horizon to zenith at its widest. The luminosity was singularly free of tremulous motion, and between it and the spectator were ragged patches of black clouds, such as often portend rain, which began to fall in torrents four hours later."

FOR some years the need has been felt at the Harvard College Observatory, of some means of making a more prompt announcement of the results of its work. It is proposed therefore to issue a series of circulars, as required, to announce any matters of interest, such as discoveries made there, the results of recent observations, new plans of work, and gifts or bequests. It is not proposed to give these circulars a wide distribution, but rather to use them as a means of bringing new facts to the attention of the editors of astronomical and other periodicals, and thus secure the immediate publication of such portions as would be of interest to the readers of these periodicals. The distributions will be made without charge to such persons as will be likely to use the results.

IN view of the unsatisfactory condition of veterinary anatomical nomenclature, we are glad to learn from the *Lancet* that the section of the recent sixth international veterinary congress detailed to give an opinion as to the necessary steps to be taken to remedy it, reported that the *Nomina Anatomica* of His be recognised as a basis for an international Latin nomenclature of veterinary anatomy, and that the work of adaptation, as well as the creation of new Latin denominations, should be allotted to certain anatomists of the countries represented, with the right of co-optation. This recommendation was unanimously adopted, and the following gentlemen were appointed to undertake this task, MM. Müller of Berlin, Arloing of Lyons, Lorge of Brussels, Sussdorf of Stuttgart, Schmalz of Berlin, Martin of Zürich, Rubeli of Bern, and Szakall of Pesth.

THE Manchester Museum was opened to the public last Sunday afternoon. The attendance was considered satisfactory, some five hundred visitors entering. Attention was pretty evenly distributed through the various departments, but a special attraction was the collection of Egyptian antiquities, recently added to the museum, and consisting of palettes for grinding metal tools, ceremonial and other flints, mace-heads, pottery (figured, polished, and rough), stone vases, art jars, &c. Objects arranged naturally, as specimens of the Porifera, also found favour. Arrangements are being made for demonstrations to be given upon the various classes of exhibits; and it is expected that this concession, rendered possible by the important pecuniary assistance from the Manchester Corporation, will be fully appreciated.

THE Executive Committee appointed to make the necessary local arrangements for the reception of the British Association in Liverpool, next year, held a meeting on Friday last, under the presidency of Sir Wm. Forwood. Among those present were the secretaries, Prof. Herdman, F.R.S., and Messrs. Isaac Thompson and Willink; the honorary treasurers, Mr. Reginald Bushell and Mr. C. Booth, jun.; Prof. O. Lodge, Drs. Hope and Forbes, and others. It was announced that the following gentlemen had been elected by the Council of the Association vice-presidents of the meeting, to be held from Wednesday, September 16, to September 23, 1896: The Lord Mayor (the Earl of Derby, K.G.), Lord Sefton, Sir W. B. Forwood, Mr. M. Rathbone, Mr. George Holt, Mr. T. H. Ismay, Principal Rendall, Sir Henry Roscoe, and Mr. W. Crookes. The President-elect is Sir Joseph Lister, Bart., F.R.S. A sub-committee was appointed to superintend the hospitable arrangements, which will be conducted on a liberal scale, and it was proposed to arrange for an excursion to the Isle of Man at the conclusion of the meeting. This excursion would occupy several days, and it was hoped that a local committee in the island would be appointed and facilitate arrangements. The honorary treasurers reported that they had received a large number of subscriptions; but as they had no reason to consider the list complete, they proposed to defer the publication of the list.

THE vagueness of the English names of our wild plants is one of the stumbling-blocks in the way of the student of botany. Those given in our text-books are, for the greater part, mere book-names—often simply translations of the Latin names—which are not, and never have been, applied to the plant in any part of the country. Even with regard to familiar names in common use, many—as for instance, eyebright and harebell—are used for quite different plants in different parts of the country. On the continent, and especially in Germany, where the more educated peasantry have a much better knowledge of wild flowers than is the case with our agricultural labourers, the state of things is still worse. In his *Internationales Wörterbuch der Pflanzennamen*, Ulrich gives, in many cases, from twelve to twenty German names for the same species; and it is stated that for some species there are more than one hundred names in use. We learn from *Die Natur* that an attempt is being made to correct this evil. The *Allgemeine Deutsche Sprachverein* of Berlin offers two prizes, of the value of six hundred and four hundred marks, respectively, for the best schemes for a uniform German nomenclature of plants for schools. It would be an immense gain to the teaching of botany in schools if something of the same kind could be done in this country. Could not the *Journal of Botany* or the Botanical Exchange Club take it up?

AFTER a part of last week's issue of NATURE had been printed off, containing a note announcing the death of Dr. George Dawson, we were rejoiced to be able to stop the press and cancel it, as a cablegram contradicted the rumour.

THE death is announced of M. A. M. Villon, the author of the "Dictionnaire de chimie industrielle" and other important works connected with chemical industry. He was only twenty-eight years of age.

AN International Marine and Fisheries Exhibition will be held at Kiel next year, in connection with a provincial exhibition for Schleswig-Holstein, and will be open from May 13 to the end of September.

THE earthquake which occurred at Rome on the first day of this month, and was noted in these columns (p. 12), was preceded by severe shocks, felt in parts of the United States, in the early morning of October 31. The shocks appear to have especially affected Ohio, Illinois, and Indiana.

ANOTHER important atmospheric disturbance approached our western coasts from the Atlantic on Friday last, 15th instant, causing further south-westerly gales and considerable damage; and before this disturbance had passed away a secondary depression reached St. George's Channel, on the following day. The rainfall which accompanied these storms was very considerable, amounting to nearly three inches in two days at Holyhead. In the storm of Saturday, the Bishop's lighthouse, off Pembroke, was struck by lightning.

THE Committee formed for the purpose of erecting a memorial to the late Dr. Valentine Ball, C.B., F.R.S., Director of the Science and Art Museum, Dublin, announce their desire to close the subscription list at an early date, and trust intending sub-

scribers will soon send their donations to the Treasurer, Dr. Samuel Gordon, Hume Street, Dublin. The subscription to the memorial is limited to one guinea. It is proposed to place a marble bust of Dr. Ball in the National Museum, the scene of his latest labours. It is further proposed, should there be sufficient funds, to have a portrait of Dr. Ball painted and placed in a position to be hereafter determined. About £120 has so far been subscribed.

THE first meeting of the one hundred and forty-second session of the Society of Arts was held on Wednesday evening, November 20. Previous to Christmas there will be four other ordinary meetings, as follows: November 27, locomotive carriages for common roads, by Mr. H. H. Cunynghame; December 4, on mural painting, with the aid of metallic oxides and soluble silicates, by Mrs. Anna Lea-Merritt and Prof. W. C. Roberts-Austen, C.B., F.R.S.; December 11, water purification by means of iron, by Mr. F. A. Anderson; December 18, machines for composing letter-press printing surfaces, by Mr. John Southward. The following papers will be read at meetings after Christmas: Dairy produce, by Mr. George Barham; the making of a great University for London, by Prof. Silvanus P. Thompson, F.R.S.; some native Irish industries, by Prof. Haddon; standards of light, by Mr. W. J. Dibden; ortho-chromatic photography, by Captain W. de W. Abney, C.B., F.R.S.; the garden in relation to the house, by Mr. F. Inigo Thomas; English book illustrations, 1860-70, by Mr. Joseph Pennell; Punjab irrigation, ancient and modern, by Sir James Broadwood Lyall, K.C.S.I.; the economic development of Kashmir, by Mr. Walter R. Lawrence. The following courses of Cantor lectures have been arranged: W. Worby Beaumont, on mechanical road carriages; Dr. J. A. Fleming, F.R.S., on alternate current transformers; Prof. J. M. Thomson, on the chemistry of metals and alloys employed for building and decorative purposes; Mr. H. Graham Harris, on refrigeration; Mr. Henry A. Miers, on precious stones; Mr. James Swinburne, on applied electro-chemistry. Two lectures, suitable for a juvenile audience, will be delivered on Wednesday evenings, January 1 and 8, 1896, by Prof. John Milne, F.R.S., on earthquakes, earth movements, and volcanoes.

A CONFERENCE, presided over by Sir Courtenay Boyle, and largely attended by representatives of municipal corporations, public companies, and others interested in the supply of electricity, was opened in the Westminster Town Hall yesterday, to consider the revised regulations made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888. We summarise the report in the *Times*. The regulations were discussed seriatim, and a number of important changes were accepted. With reference to the Board of Trade definition of electrical pressure, Prof. Ayrton, who, with Mr. Compton, represented the Institution of Electrical Engineers, proposed that the expression "pressure" should mean "the difference of electrical potential between any part of any conductor and the earth, or between any two adjacent wires on the three or five-wire system." The Chairman promised that the proposal should receive careful consideration. He added, that he intended to advise the Board of Trade to raise the alternating current limit from 100 volts to a higher figure, say to 220 volts, or thereabouts. With regard to the low-pressure continuous current limit, he thought that it might be raised slightly above 300 volts. Discussion took place upon the regulation that "no high-pressure electric line shall be used for the transmission of more than 200,000 watts, and Mr. Compton suggested that the limit should be 500,000 watts." The Chairman said he intended to advise the Board of Trade not to adhere to the limit of 200,000 watts, but he thought that of 500,000 watts a little too high. He offered to make an important amendment in the clause referring to tests of insulation, the clause in its amended form reading: "Every electric main shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a main." With reference to the clause requiring a test of insulation before a high-pressure circuit can be brought into use, the Chairman suggested the introduction of words providing that the test required in the case of electric lines should be twice the pressure to which the lines were to be subjected in use, and in the case of machines or apparatus intended to form part of a high-pressure circuit 50 per cent. more. As to the question of leakages from gas mains, and the accumulation of explosive mixtures in electrical conduits and street boxes, the Chairman said he would be prepared to recommend the Board of Trade to accept a clause based on that suggested by the Institution of Electrical Engineers, that is to say, imposing upon undertakers the obligation to take reasonable means to prevent the influx and accumulation of gas in boxes, and to give notice to the gas companies whenever an accumulation of gas therein was discovered. He accepted that clause on the understanding that there must be some further regulation with regard to the ventilation of street boxes.

A NOTE on the tinfoil grating as a detector for electric waves, by T. Mizuno, appears in the *Journal* of the College of Science of Tokyo. The author has been repeating and extending Aschkinass' most interesting experiments on this subject. The gratings employed are formed by coating a flat wooden block with tinfoil, and then cutting on it a number of fine parallel slits with a sharp knife. Two gratings have been used, one having a resistance of 130 ohms, and the other of 232 ohms. The wave-length of the electric radiation employed was about 60 cm. On exposure of these gratings to the electric radiation, the resistance fell in some cases as much as 11 ohms and 42 ohms respectively. Gentle tapping was sufficient to cause the resistance to increase to almost its former value. The experiments indicate that the angle which the plane of polarisation of the radiation makes with the strips of the grating influences the results to a certain extent, a greater decrease of resistance taking place when the strips are perpendicular to the plane in which the primary oscillations take place. The author has made some experiments with a view of determining whether the change in resistance is due to a molecular change in the tinfoil, or whether the change is a mechanical one. He has constructed gratings in which the spaces between the strips were much larger than in the above gratings. With this grating, however, no indication of a decrease of resistance under the action of electric radiation was observable. Gratings formed of fine german-silver wire and fine iron wire, also, showed no effect. The author concludes that the change is a mechanical one, and suggests that it may be due to small jagged points on the neighbouring strips coming into contact under the influence of the electric waves.

THE competition for mechanical carriages, which was arranged by the *Times-Herald* of Chicago to take place on November 1, has been postponed until the 28th inst., at the request of a number of the competitors who had entered for the competition, but were not prepared. According to the *Journal* of the Society of Arts, the *Times-Herald* thereupon offered a prize of £100, to be divided amongst those competitors who went over the course arranged for the race. This course extends over the line of boulevards which surround Chicago to a place named Waukegan on the lake shore, thirty miles to the north of the city. Several vehicles started, but only one completed the course—the carriage entered by A. Mueller, of Decatur, Illinois. The vehicle carries four persons, and is driven by a gasoline motor. The total distance covered was ninety-two miles, and the time taken 8 hours 44 minutes.

IF the Buchan Field Club succeeds in carrying out the ethnological survey sketched in its *Transactions* (1895) by Mr. T. Gray, who gives also the results of preliminary observations made by Mr. J. F. Tocher and himself, it will not only fill an important hiatus in the ethnographic chart of Great Britain, but also set an example which may be followed with advantage by similar societies all over the country. The observations referred to were made at the annual Buchan gathering, held this year at Mintlaw, and though no definite conclusions can be safely made from them, they show that a continuation of the survey will lead to interesting results, and help to settle a number of vexed questions in ethnology and history. The class of people at such gatherings as that at which the measures were made is very typical of the natives of the district, and the statistics obtained by Mr. Gray, and those working with him, should be of great value in determining the accurate anatomy of the typical native of Buchan.

A VALUABLE contribution to the existing literature of water-bacteriology has been recently made by M. N. van der Sleen. This monograph is a record of bacteriological investigations made during more than four years on the Amsterdam water-supply. The author has identified and described no less than 80 varieties of water microbes, some of which he regards as new, whilst others are identical with those already discovered by other investigators. A most helpful diagnostic aid is furnished by the 118 excellent photographic figures of microbes which accompany the text. No cholera bacilli were at any time found, and only one form which at all resembled them, although a careful search was made at a period when cholera had broken out in the vicinity of the intake of the water-supply, and when the river Vecht was declared contaminated by the authorities. M. van der Sleen has endeavoured to give water-bacteriologists fresh assistance in the difficult task of recognising the bacteria found in water, and the conscientious care with which he has accomplished this tedious piece of work eserves the highest praise.

THE well-known difficulty of obtaining instruments which will indicate rapid variations of temperature, has induced Mr. Paul Czermak, of Graz, to try thermo-elements with very fine wires for meteorological observations. These are better than thermometers with platinum bulbs, and much superior to glass-bulb thermometers, where rapid variations are to be measured. One of the instruments constructed consists of a thermo-couple of copper and constantane wire 0·1 m.m. thick. The ends are soldered to two hollow copper cylinders drawn into a point at the ends, and mounted side by side on a wooden support. The cylinders contain water, and hold ordinary thermometers indicating the average temperature. This instrument, when used in circuit with a strongly-damped aperiodic galvanometer, showed variations amounting to 2° C. within five minutes on a clear frosty Tirolese morning. The stratification of the air in layers of different temperatures was less in the afternoon. The paper describing these results, in *Wiedemann's Annalen*, also gives an account of a "relative actinometer" consisting of two concentric copper cylinders. The interior one is empty, and across one end of it are placed three thermo-couples in parallel, protected from draughts by a plate of rock-salt mounted obliquely to the axis of the cylinders. This instrument indicates the slightest variations of the intensity of solar radiation, such as those produced by different thicknesses of a filmy cloud.

SIR ROBERT BELL is said to have discovered a very large river flowing into James Bay. The river rises near the upper waters of the Ottawa, and drains a large area hitherto unexplored. The volume of water is so great as to make the river rank among the largest in Canada. It is navigable through the greater part of its course, but about one hundred miles from its mouth the descent becomes greater, and a series of rapids are formed. The name "Bell River" is proposed, in honour of its discoverer.

WE are indebted to the Vienna correspondent of the *Times* for the following information. At the beginning of this month the German Society for Geographical Discovery, and the special committee which has been organised for the purpose of promoting the exploration of the South Polar regions, held a joint sitting in Berlin, which Herr Julius von Payer, the well-known Austrian Arctic traveller, was requested to attend. In the course of the proceedings he was invited to modify the arrangements he had himself made in connection with the expedition to North-East Greenland, and, if possible, to co-operate with the Germans in undertaking an expedition to the South Pole. Herr von Payer replied that, although he was not adverse to the proposal, he could make no definite statement until he had ascertained the opinion of the Vienna committee, who had in hand the arrangements relative to the intended Austro-Hungarian expedition to Greenland. Within the next few days the Vienna committee will meet, under the presidency of Count Wilczek, with the object of considering the German proposals. The invitation to act in concert with Germany seems to be regarded with favour in Vienna. Herr von Payer has stated that, in view of the multitude of scientific and artistic opportunities afforded by a visit to Antarctic regions, he would have no objection to alter the destination of the contemplated Austro-Hungarian expedition. During the preliminary discussion, which took place in Berlin, it was decided that the expedition should consist of two steamers equipped on the most improved lines. The first landing would be effected on Kerguelen Island, whence it would be possible to proceed in two different directions—namely, either south or south-west, leading to a totally unknown region, or south-east towards the Magnetic Pole, in which direction a continent is supposed to exist. Geographical discovery, of course, would be the chief object of the expedition, but equally valuable results are expected to accrue to botany, zoology, and geology. About eighteen months would be required to prepare and organise the expedition, and the cost is estimated at about 1,000,000 marks. In order to achieve success the expedition would remain absent from two and a half to three years, it being considered essential that at least two winters should be spent in the Antarctic regions.

THE seventh number of the current volume of the *Verhandlungen der Gessellschaft für Erdkunde zu Berlin* contains a discussion, by Hermann Moedebeck, of the project of reaching the North Pole by balloon, with the conclusion that, in our present ignorance of Arctic wind currents, it is impossssible to decide as to the probabilities of success. Dr. Hedin continues an account of his journey across the Takla-Makan desert east of Yarkand. Wegener gives a summary of the papers read at the Geographical Congress in London. The volume refers to the departure of an expedition, under Humpelmayr and Sperhinger, from the Somal coast, in order to march southwards across the Galla country to Mombasa. The more important contributions offered to this Society are published in its *Zeitschrift*, of which we have received the fourth part of vol. xxx. This contains the third part of the report by the cousins Sarasin upon their travels in Celebes, describing the journey, in the winter of 1894, across the centre of the island from Boni to the Gulf of Tomini. The report is mainly narrative, but contains many notes on the zoology, anthropology, and geology of the district traversed. The monographs previously issued by the Sarasins, containing zoological and anthropological discoveries made during their visit to Ceylon, are well known, and encourage us to expect important results from their present journey.

THE principal article in the last number of the *Mittheilungen* of the Geographical Society of Vienna (Bd. xxxviii. Nos. 7 and 8) is a memoir, by R. Payer, on the districts of Eastern

Peru included in the Amazon basin. It consists mainly of an account of the various diseases. Dr. Gavazzi gives a short account of the hydrology of the lower part of the River Krka in Dalmatia. Among the smaller articles contributed is a biography of Huxley by Dr. Haas, an account of the German expedition of Lieut. von Carnap-Querheimb and Dr. Grüner in Togoland, and of Dr. Krüger up the Palena river in Chile. There is also a short notice of Glave, who did excellent work under Stanley on the Congo, and died there in May last. It also contains a report on the various expeditions engaged in work in Africa. From this we learn that Capt. Bottego is attempting to march from Barawa, on the Somali coast, to Logh, on the Juba; thence he is to cross to Lake Rudolf, and explore the course of the Omo, from its mouth to the point where Prince Ruspoli was killed. The King of Italy and the Italian Government have each contributed 40,000 lire for this expedition. Prince Boris, the well-known Russian sportsman, has been shooting in the Ogaden country in Somaliland, and has traced the Dachato river to its confluence with the Webi Schebeyli. Dr. Humpelmayr left Berbera in June in order to march across East Africa from north to south, as far as Mombasa.

THE Zoological Society have just issued the thirty-first volume of the *Zoological Record*, containing a summary of the zoological literature published in the year 1894. The various articles have been prepared by Messrs. J. A. Thomson, R. Lydekker, R. Bowdler Sharpe, G. A. Boulanger, W. A. Herdman, B. B. Woodward, D. Sharp, F. A. Bather, R. Hanitsch, and Miss Florence Buchanan. The whole volume has been edited by Dr. D. Sharp, F.R.S., of the Cambridge University Museum. Great credit is due to the Society and to the Editor for the early date at which this volume has been published. We observe that the corresponding *Record*, just finished in Wiegmann's *Archiv*, only relates to the year 1890, being thus *four years* behind that of its English rival. A very useful feature in the present volume is the newly revised list of abbreviations used in the *Record* for the titles of the *Journals* and *Transactions* that contain zoological papers. These periodicals are now, as is well known, exceedingly numerous, and increase in number every year. Some sixty or seventy new titles have been added to the present edition. The principal libraries in London and Cambridge, in which the various periodicals are to be found, are indicated by key-letters attached to each title, so that the recorder in each subject may always know where to go for his information. We observe that the present volume contains no records for the Crustacea, Arachnida, Myriopoda, and Cœlenterata, the naturalists to whom these subjects were assigned (Mr. R. I. Pocock and Dr. S. J. Hickson) not having delivered their manuscripts at the promised date. These deficiencies are much to be regretted; but the early appearance of a *Zoological Record* is a matter of so much importance, that we cannot but approve of the Editor refusing to wait for the convenience of his tardy coadjutors.

A FLORA of the Gramineæ of France, Belgium, and Switzerland is in preparation by M. T. Husnot, of Cahan, near Athis (Orne).

THE Christmas course of lectures, adapted to a juvenile auditory, at the Royal Institution, will be delivered this year by Prof. John Gray McKendrick, F.R.S. The subject will be "Sound, Hearing, and Speech," and the lectures will be experimentally illustrated.

A SKETCH of the life and personality of M. Berthelot, now Minister of Foreign Affairs, appears in the current number of the *Chemist and Druggist*. "The Republic has no use for chemists," is said to have been the remark made by the tribunal which condemned Lavoisier to the guillotine. The words are probably apocryphal, but, at any rate during this century, France has in many ways shown her appreciation of the abilities and work not only of chemists, but of all her scientific investigators.

IN our report of the opening of the Chingford Museum (p. 16), the writer inadvertently wrote "Dengey Hundred" in reference to Mr. Walter Crouch's collection of shells. He desires us to state that the collection was made in the Becontree Hundred, which comprises the Forest District.

THE Central Hydrographic Office of Vienna has published its first *Jahrbuch* containing daily or monthy rainfall values at 861 stations, and tidal observations at 493 stations, for the year 1893. The work occupies 562 large folio pages, and contains brief discussions of the observations, arranged according to the various river systems, and a map showing the yearly distribution of rainfall over the entire area. The publication is a valuable contribution to meteorological and hydrographical science.

THE additions to the Zoological Society's Gardens during the past week include a Blotched Genet (*Genetta tigrina*), two Crossed Snakes (*Psammophis crucifer*), a Smooth-bellied Snake (*Homalosoma lutrix*), a Rough-keeled Snake (*Dasypeltis scabra*), a Many-spotted Snake (*Coronella multimaculata*), a Hygian Snake (*Elaps hygiæ*) from South Africa, presented by Mr. J. E. Matcham; eight Great Tits (*Parus major*), British, presented by Mr. Brunsden; a Puffin (*Fratercula arctica*), British, presented by Dr. J. B. Johnson; two Lions (*Felis leo*, ♂ ♀) from Africa, deposited; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, purchased.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram, received from Kiel on November 18, announces the discovery of a new comet by Mr. Perrine at the Lick Observatory on the 16th inst. At the time of observation the comet was in R.A. 13h. 44m. and Decl. 1° 40′ N.; accordingly, it was nearly midway between ζ and τ Virginis, and would rise at London about 3.40 a.m. It is described as having a bright tail.

THE NEW MEROPE NEBULA.—The round bright nebula very close to Merope, in the Pleiades, which was discovered by Prof. Barnard in 1890, has recently been observed by him with special reference to its position (*Ast. Nach.* 3315, p. 42). With respect to Merope, its position angle for 1895·67 was 166°·6, and distance 33″·58; these figures agree remarkably well with the earlier measurements, and they indicate that the place of the nebula can be determined with such precision, that repeated observations may be expected to show whether it has any proper motion, or physical connection with the star. It is remarked that the nebula is only difficult in small telescopes because of its extreme closeness to the star, and that away from the star it would be an easy object in almost any telescope. The use of an occulting bar in the eyepiece of the telescope would probably facilitate observations of the nebula.

NUMBER OF NEBULÆ.—The number of known nebulæ has during the past few years been so largely increased by the labours of different observers, and the modes of publication have been so varied, that Dr. Dreyer's new index catalogue of the recent discoveries will be highly appreciated (*Mem. Roy. Ast. Soc.* vol. li. p. 185). This is a continuation of the well-known "New General Catalogue," which contained particulars of the 7840 nebulæ and clusters known up to the end of 1887, and brings the information to the beginning of the present year. The seven years' observations have resulted in the detection of 1529 new nebulæ, so that the general catalogue and the index together give the positions and descriptions of 9369 objects. More than half of the new discoveries are to be placed to the credit of M. Javelle, who has the advantage of employing the great refractor of the Nice Observatory. It is notable that only a very small proportion of new nebulæ has been discovered by the photographic method. Most of the objects included in the index are very small and faint, and it is remarked that they are probably only a small fraction of the total number visible in large telescopes. Dr. Dreyer considers it desirable that some of the possessors of large telescopes should turn their attention from the search for very faint nebulæ to "the less showy but more useful work of verifying the many old nebulæ which require re-observation."

A NEW STAR IN THE CONSTELLATION CARINA.—The first number of the Harvard College Observatory *Circular* contains a note to the effect that, from an examination of spectrum-photographs taken at the Arequipa Station of the Observatory, Mrs. Fleming has discovered that a new star appeared in the southern constellation Carina in the spring of this year. A photograph of a number of stars in the constellation contained a spectrum having bright hydrogen lines accompanied by dark ones of slightly shorter wave-length. Upon comparing this spectrum with those of Nova Aurigæ and Nova Normæ, it was seen that all three resembled one another, and were apparently identical in their essential features. A later photograph showed a slight change in the spectrum; a line at about wave-length 4700 being as bright as the hydrogen lines, though on the earlier photograph it was barely visible. These facts led to a close examination of all the sixty-two photographs of the region containing the star. Upon the first, taken in May 1889, no trace of the star could be made out, though stars of the fourteenth magnitude had recorded their existence. The star first appears on a negative taken on April 8 of this year, and last upon one obtained on July 1, its magnitude during the intervening period having diminished from the eighth to the eleventh. The approximate position of the star is R.A. 11h. 3·9m., Decl. − 61° 24′.

CHOLERA IN GERMANY IN 1894.

THE part just issued of the *Arbeiten aus dem Kaiserlichen Gesundheitsamte* is devoted to a very elaborate report on all the cases of cholera which occurred in Germany during the past year. The inquiry has been so arranged that each district is responsible for its own report. Thus Prof. Dr. von Esmarch has drawn up the document relating to East Prussia, Prof. Dr. Flügge furnishes the statement for Schlesien, Prof. Dr. E. Fraenkel describes the outbreak which took place in the neighbourhood of Marburg, and so on, whilst a general introduction has been written by Regierungsrath Dr. Kübler.

In all 1004 cases of cholera occurred between May 23 and the middle of December, 1894, out of which 490 ended fatally. These figures, taking the population of the Empire at its official estimate of 49,429,470, represent 0·2 cases of cholera per 10,000, and a mortality from cholera equal to 0·1 per 10,000. The report is extensively illustrated, but one of the most instructive appendages is a map giving a graphic representation of localities in which cholera was notified. Here at a glance it may be seen how Germany suffers in this respect from her close proximity to Russia and Galicia in the eastern portions of her Empire, by far the greater number of outbreaks having taken place in East and West Prussia, whilst in the districts bordering on France, Belgium and Holland, hardly any cases of cholera occurred.

Dr. Kübler des not hesitate to assert that practically all the cases of cholera which took place were attributable to fresh infection imported into the country. West Prussia was last year at a particular disadvantage in this respect, for whilst cholera has invariably found its way from Russia along the water-ways, this part of Germany, being so intimately connected with Russia by the Vistula, in 1894 a specially alarming outbreak of cholera raged in these Russian and Galician districts, and thus every opportunity was afforded for its ingress into Germany.

The various reports seem to be almost unanimous in stating that cholera is disseminated throughout the Empire well-nigh exclusively by means of the traffic along the rivers or water-ways of the country, and that it is here that the greatest watchfulness has to be exercised. Such surveillance has, however, exerted a most salutary influence upon the hygienic conditions obtaining on ships, and although the interference was in the first instance opposed by the men, the latter are now most eager and active in carrying out the sanitary improvements, and the best results have ensued.

It is interesting to note that not a single case of cholera occurred in Hamburg,[1] and only six in the whole of the Elbe district.

There cannot be a doubt that these most satisfactory results are a direct consequence of the splendid way in which the regulations drawn up by the German Cholera Commission of 1893 were carried out, and that it is to the conscientious manner in which the various officials fulfilled their instructions, that Germany owes her comparative freedom from cholera and its restriction when an outbreak did occur.

[1] The fatal case of cholera, which occurred in the Hamburg Hygienic Institute, is not included, as this was due to accidental infection during the carrying out of some laboratory experiments on cholera.

Prof. Flügge cites an interesting table confirming the improvement which has taken place in combating cholera, in which the total number of cases of cholera which have occurred in Oberschlesien from the years 1831 to 1894 are given.

Year.	Cholera cases.	Year.	Cholera cases.
1831	1658	1855–56 ...	5498
1832	3270	1866	9069
1836	4324	1867	4438
1837	1159	1872–73 ...	2332
1848–49 ...	5903	1874	2499
1851	898	1893	7
1852–53 ...	3856	1894	346

This improved condition, which is so apparent within the past twenty years, Prof. Flügge ascribes to the achievements of Robert Koch, whose labours have revealed not only the nature of cholera, but also the most effective way of dealing with it and crippling its power.

But perhaps the most striking testimony to the effectiveness of the measures taken to stamp out cholera, is to be found in the fact that in spite of the prevalence of cholera in East and West Prussia, the army manœuvres were conducted on a large scale in this district, and no cases of cholera occurred amongst the troops. As an instance of the precautions taken, it may be interesting to read the following instructions which were issued, such instructions being by no means the most elaborate which were carried into execution.

During the mobilisation of troops on the Vistula, no eatables were allowed to be taken; to prevent the river water from being drunk, casks of boiled drinking water accompanied the soldiers, and every man was provided with an infusion of tea; further, it was ordered, and most strictly carried out, that all articles of clothing which had come in contact with Vistula water, were not to be returned to the barracks, but to be sent straight to the disinfecting station, and the men were further obliged to wash their hands with soap and pure spring water on the parade ground each time after the various drills had been gone through.

There seems to be no doubt that personal disposition to cholera, as in diphtheria and other zymotic diseases, varies with the individual, and members of a cholera-stricken household, although not themselves affected, may in cholera, as also in diphtheria, become the transmitters of the disease. This is an accepted fact in Germany, and Dr. Kübler states that last year this received fresh confirmation from the bacteriological evidence afforded by numerous investigations of perfectly healthy persons in cholera surroundings. The isolation of these suspects, Dr. Kübler regards as an important measure in helping to restrict cholera-infected areas.

This disposition to cholera, even in cholera-disposed individuals, appears to vary at different seasons of the year, and the consensus of opinion, derived from all parts of Europe, decrees the late summer and autumn as the period when the chances of infection are greatest. What the special circumstances are which determine this seasonable predisposition, no one rightly understands, and a great diversity of opinion on this question exists; but there can be no doubt as to the facts, and the following statistics of cholera cases per month, collected over a period of more than thirty years in Schlesien, bring out this point very clearly.

January ...	743	July ...	2029
February ...	515	August ...	7065
March ...	381	September ...	11065
April ...	591	October ...	10787
May ...	712	November ...	6949
June ...	1446	December ...	2648

The organisation and elaborate machinery necessary to combat effectively with cholera, and the discipline with which the sanitary precautions have been carried out in Germany, call for ungrudging admiration; it is, therefore, with the more surprise that we learn from Prof. Flügge's report how much remains yet to be accomplished in the management of so important a matter as disinfection. The most approved apparatus was frequently rendered useless by the ignorance of those to whom the work of disinfection was entrusted. "The modern practice and technique of disinfection is something," writes Prof. Flügge, "which every doctor does not *eo ipso* understand or can learn either from

books: it requires, of necessity, a thorough theoretical and practical training. The control of disinfection is in the majority of cases left in the hands of police officials who have no knowledge of the subject whatever, and thus numerous mistakes are made, and much unnecessary damage to property ensues. . . For cholera-disinfection, in my opinion, special courses of instruction should be provided for disinfectors in both the theoretical and practical application of the subject."

We cordially commend the perusal of this valuable report to our own public authorities, who might, thereby, possibly be stimulated to take some serious and effective steps in staying the ravages of, to us, a far more deadly enemy, *i.e.* diphtheria. The Hamburg cholera disaster has not been without its lesson to Germany; surely we need wait no longer for our authorities to be similarly roused to successfully combat diphtheria.

G. C. FRANKLAND.

A JAMAICA DRIFT-FRUIT.

THE dispersal of plants by oceanic currents is a subject full of interest, and no apology is needed in bringing it forward if thereby we stimulate those who have opportunities for observing the effects of this agency in various parts of the world. The valuable contribution made to the literature of the subject by Mr. W. B. Hemsley, F.R.S., in the "Botany of the *Challenger*," and since added to by himself, Mr. Guppy, and others, cannot fail to enlarge our knowledge in regard to the origin of plant-life on oceanic islands as well as on the littoral of much larger areas. Our first acquaintance with the fruit of the remarkable *Lodoicea* of the Seychelles, for instance, was as a waif floating on the surface of the sea, and hence one of its familiar names *Coco-de-mer*. In the West Indies the ripe fruits of a palm unknown in the Greater Antilles are continually brought by the Gulf Stream from the south, and washed ashore at Jamaica and other places. These are locally called "Sea apples" or "Sea cocoa-nuts." They are the fruits of the Bussu palm (*Manicaria saccifera*), found in Trinidad and the adjacent mainland of South America. The white kernel is sometimes fresh enough to be eaten after long immersion in salt water. This fruit was gathered by Sloane as long ago as 1687, and he remarked that it was frequently cast on the north-west islands of Scotland by the currents and the sea. The seeds of the Cocoon (*Entada scandens*), large brown beans about two inches in diameter, are so frequently cast ashore in various parts of the world, that they are commonly called "Sea-beans." Several plants have been raised at Kew from seeds picked up at the Azores. It is also mentioned by Robert Brown that a plant of *Cæsalpinia Bonduc* was raised from a seed found stranded on the west coast of Ireland. Linnæus also seems to have been acquainted with instances of germination having taken place in seeds thrown ashore on the coast of Norway. These are well-known and familiar examples of drift-fruits. The record might be considerably enlarged without more than touching on the fringe of the subject. It is hoped that botanists in suitable localities will give attention to this comparatively unworked field of investigation, and record the results of their observations.

In NATURE (vol. xxxix. p. 322), I gave an account, with woodcuts, of a drift-fruit that was collected on the shores of Jamaica. This had a very singular history. It had, in the first instance, been gathered nearly three hundred years ago, and presented by Jacob Plateau to Clusius. It was figured and described by many of the older botanists, but up to the time of writing in 1889 the plant bearing it had not been identified. The object I had in view in drawing attention to it in the columns of NATURE, was to enlist the interest of those likely to throw light upon its origin, and lead eventually to its identification.

FORMER HISTORY.

It is somewhat remarkable that a drift-fruit so plentifully brought by the Gulf Stream, and cast ashore in the West Indies and elsewhere, should have been so long a mystery.

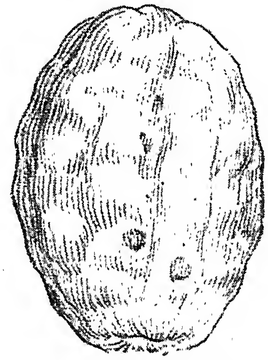
The first notice, so far as I can gather, is given with a woodcut, by Clusius, in his "Exoticorum libri decem," lib. ii. cap. 19. This work bears the date of 1605. The following is Clusius' description, which is reproduced as it appears in the original, together with his representation of the fruit:—

Exotici fructus à Jacobo Plateau & aliis accepti.

Cap. xix.

Aliquot exoticos fructus mittebat ad me Jacobus Plateau, quum intelligeret me Exoticorum Historiam scribere, ut quantum posset meos conatus etiam in hac materia juvaret, sed quos, præter binos, jam antè videram & descripseram.

Binos igitur illos, quos dixi mihi antè non fuisse conspectos, cum binis aliis aliunde acceptis, in tabella exprimi curabam quam hîc subjicio. Primus illorum quos Plateau mutuo dabat, binas uncias cum semisse longus erat, quatuor in ambitu crassus, cine-



Drift-fruit (after Clusius).

racei coloris, quem aliquo operimento tectum fuisse arbitrabar: in quinque partes dividi posse, venæ per longitudinem ductæ indicabant; alioqui eminentibus aliquot tuberculis instar vesicularum obsitus erat, quæ aperta, inanes & inæquales lacunas ostendebant spadicei coloris & splendentes, quasi semen aliquod continuissent: valde durus autem erat is fructus, & adstringente facultate præditus.

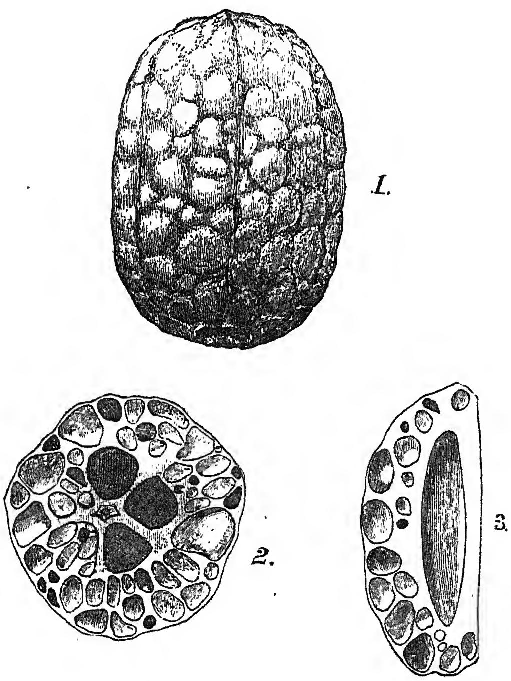
About sixty years afterwards, Johannes Jonston, in "Historia Naturalibus de Arboribus et Fructibus" (1662), p. 102, refers to the same fruit. In 1680 both the description and figure given by Clusius were reproduced by J. Bauhin in "Historia Plantarum," tom. i. lib. 3, cap. cxi. fig. 1. It is next mentioned in Sloane's "Catalogus Plantarum" (1696), p. 214, in the following words: "Fructum nunc saepissime collegi in Insulæ Jamaicæ littus ejectum cum aliis maris recrementis." The fruit itself was recognised in 1889 by Mr. E. G. Baker, as existing in the Sloane Collection in the British Museum (Natural History) where it is labelled "No. 1656." Further, in 1764, a small and somewhat unsatisfactory figure was given in "Petiveri Opera," t. lxxi., fig. 5, with the information: "It is a hard oval fruit with seed-holes round its surface. Cat. 605. Found on the shores of Jamaica." In all the cases enumerated above, it is represented in its water-worn condition as given in Fig. 1 below. It is a hard bony fruit, about an inch and a half to two inches long, marked externally with mammillated protuberances corresponding (as shown in Figs. 2 and 3) with numerous cavities or resin-cysts existing in its walls. In the transverse section, Fig. 2, it may be seen that the fruit is normally five-celled, but two are suppressed. The seeds are solitary, and contain abundant albumen. There is no doubt it was once a drupaceous fruit, but the fleshy outer layer or sarcocarp has decayed or worn away by the action of water. What is now left is, in many respects, so unlike the fruit in the fresh state, that its origin must always have been somewhat difficult to trace.

In passing, it may be noticed that it possesses ideal qualities as a drift-fruit. The numerous closed cavities contained in the walls render it very buoyant, and easily influenced by the action of the wind, while its hard texture and the presence of resin preserve it from becoming water-logged or decayed. There is no record that the seeds have germinated after long immersion in salt water, or that the plant has established itself in a new locality outside its present area. These are interesting points for further observation.

RECENT HISTORY.

The chapter in the recent history of the fruit opened in 1884. It was then collected, by the writer, with other drift-fruits on the sandy-spit of land known as the Palisadoes enclosing Kingston Harbour, Jamaica. On this land the Botanical Department had

established a cocal or cocoa-nut plantation with about 25,000 trees. Many of these are now in full bearing, and bring a regular revenue to the Government. The locality is exposed to the full force of the waves from the Caribbean Sea, and large quantities of wreckage, sea-weeds, and drift-fruit are thrown high up on the beach. The drift-fruits collected in 1884 were forwarded to Kew, and most of them were easily determined. The fruit under notice was, however, quite new, and it was placed in a cabinet with others until sufficient material had accumulated to lead to its identification. In November 1887, a further specimen was sent to Kew, by Mrs. Hubbard. This, singularly enough, had been picked up on the shore of Bigborough Bay, in the south of England. It is quite possible in this instance it may have been derived from a wreck, or thrown overboard from a passing ship, but, as Mrs. Hubbard aptly remarks, "such a fruit is not among the usual articles of import, and further, our south-west coasts are very likely to receive Gulf-stream waifs and strays." It was still, however, undetermined. The presence of the resin-cysts was always regarded as a character of some value. From the large collections in the Museums of Economic Botany at Kew a clue was at last obtained by the assistant, Mr. J. M. Hillier, in



Representation of a Jamaica drift-fruit (natural size). 1, external aspect; 2, cross-section; 3, longitudinal section.

the fruits of *Humiria gabonensis*, belonging to the natural order *Humiriaceæ*. These were somewhat smaller and more globular than the Jamaica drift-fruit, and, being covered with a brown fibrous epicarp, looked very different. The bony endocarp was, however, similar in character and plentifully furnished with resin-cysts. The natural order *Humiriaceæ* is a small one, and consists of plants entirely confined to tropical America, with the single exception of the species already mentioned. The theory was that the drift-fruit had been derived from tropical America, and not from Africa. The American genera of *Humiriaceæ* are *Vantanea*, *Humiria*, and *Sacoglottis*. The balance of probability at the time was in favour of *Humiria*, and possibly of *H. balsamifera*. The fruit of the latter was, however, unknown. After the publication of the note in NATURE special attention was given to the subject, with the result, as shown later, that the mystery connected with it was completely solved.

In 1887, Colonel Feilden, a member of the West India Exploration Committee stationed at Barbados, found a specimen on the beach of that island, while two years later Dr. H. A. Alford Nicholls, of Dominica, fished up a similar specimen off the sland of Mustique, between St. Vincent and Grenada.

The most important result was, however, obtained from the island of Trinidad. In March 1889, Mr. J. H. Hart, Superintendent of the Botanic Garden at Trinidad, wrote as follows: "I am extremely pleased that you called my attention to the Jamaica drift-fruit. I remember the specimens well, and cut several of them in Jamaica at the time we were packing the set you sent to Kew for the *Botany* of the *Challenger* Expedition. As soon as I read your article in NATURE, I commenced a search among the material in the herbarium here, and found a drawing of *Sacoglottis*, by Crüger,[1] with dissections of the flower and fruit. These made it evident that the plant which produces the unknown fruit is a native of Trinidad. Feeling further interested in the matter, I communicated with Mr. Syl. Devenish, the friend and companion of Crüger on many of his excursions, and I learnt further particulars as follows. When travelling in the forest at Irois, in the south-eastern part of the island, they found on the beach specimens of the fruit in question. Following up the stream they came to the tree producing it, from which, I presume, the drawings were taken. In addition, Mr. Devenish gave me a fruit, which I now send, to show there can be no mistake in the matter. This was collected by himself on the spot, so that there can be no doubt of the identity of the species we are both discussing. Mr. Devenish states that the tree is very rare. He saw but two in all his travels through the island. It is known locally as *Cojon de Burro*. It is probable that a greater portion of the drift-fruits found in Jamaica and elsewhere are produced on the mainland of South America, and are brought down by the flood waters of the Orinoco and the Amazon." On receipt of Crüger's drawings, Prof. Oliver at once expressed the opinion that they afforded a satisfactory solution of the problem. He stated: "The fruit of *Sacoglottis amazonica* is unknown, but Crüger's drawings correspond well with the floral analysis of the plant given by Dr. Urban." The latter monographed the *Humiriaceæ* in Martius' "Flora Brasiliensis."

It may be mentioned, in passing, that Dr. Urban had already ventured an opinion that the fruit might belong to *Sacoglottis*, but there were no fruits available for comparison in the herbaria at Kew, Berlin, or Paris.

The *Humiriaceæ* consist of trees or shrubs mostly with balsamic juice. The Balsam of Unieri, possessing the properties of Peruvian and Copaiva, is the produce of *Humiria floribunda*. A preparation of the juice of this and *H. balsamifera* has the odour of Storax, and is made into ointment and used internally. Although very different in habit, the *Humiriaceæ* are not far removed from the Flax order, *Lineæ*.

Sacoglottis amazonica is a moderately large tree, thirty to forty feet high, with a stout stem of an ash-grey colour. The leaves are alternate, slightly crenulated along the margin, and with two small glands at the base. The flowers are arranged in lateral panicles, petals yellowish-green, the anthers are ten in number, five long, five short, joined at the base. There is an annular disk closely girding the base of the ovary; the latter is five-celled, with a solitary ovule in each cell. The fruit was unknown until recently. It is described for the first time below.

Crüger's drawings, so thoughtfully sent by Mr. Hart, consisted of two sheets of dissections, with descriptive notes, all apparently done on the spot. They are minutely drawn, and give characters that are omitted even in the elaborate drawings in the "Flora Brasiliensis." They remind one of the careful field notes and sketches made by Sir Joseph Hooker in the Himalaya, by the late Dr. Thwaites in Ceylon, by Sir John Kirk in tropical Africa, and Mr. C. B. Clarke in India. The more recent botanical explorers are in no way behind their predecessors in regard to the skill and energy shown in selecting and drying their plants; but it may be mentioned, without disparagement of their invaluable services to science, that they do not, as a rule, devote the same attention as the older botanists to field notes and dissections, and thus a large amount of very interesting and accurate information is lost. Such information can never be obtained from the specimens themselves, however well they are mounted, in our National herbaria. It is certain that but for Crüger's drawings in this instance we should not, even now, have had the means of determining the origin of the Jamaica drift-fruit.

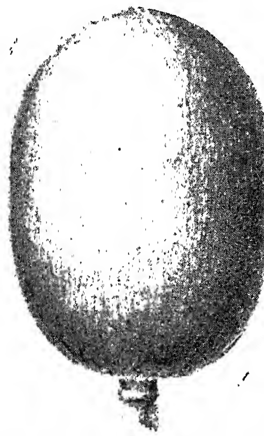
Since 1889 it has been sought to obtain fresh fruits of *Sacoglottis amazonica* from Trinidad or South America. These, so far, have not been received. There can, however, be no doubt of the identity of the plant. In order to obtain final evidence on the subject, my colleague, Dr. Stapf, the Assistant for India

[1] Dr. Herman Crüger, formerly Colonial Botanist and Superintendent of the Botanic Gardens, Trinidad.

in the Kew Herbarium, has been good enough to undertake a critical examination of Crüger's drawings, and compare them carefully with the description and plates of the species in the "Flora Brasiliensis." The result of the investigation is contained in the following note :—

"Crüger's drawings of *Sacoglottis*, Mart. 'Cojon de Burro,' October 13, 1861, agree perfectly with *Sacoglottis amazonica*, Mart. ('Flora Brasiliensis,' vol. xii. pt. 2, p. 449, tab. xcv.) The analyses are very carefully done. The sketch of the base of the leaf, for instance, shows the characteristic two glands which had been overlooked by Martius as well as Urban. As the fruit has not been previously described, it appears desirable to give a description of it drawn up from Crüger's drawings, as well as from the several specimens in the Kew Museum.

"Fructus subdrupaceus, ellipsoideus, $1\frac{1}{2}$-$1\frac{3}{4}$ poll. longus, 1-$1\frac{1}{4}$ poll. latus, exocarpio vix 1 lin. crasso, endocarpio osseo, extus subbullato, cavernis resina impletis abundante, 5-loculari vel saepius ob ovula loculosque 1-4 aborta 4-1-loculari ineunte



Fruit of *Sacoglottis amazonica*, Mart. (after Crüger).

germinatione valvis 5-trigonis ab axi 5-alata semina inter alas in loculis late apertis exhibente sedentibus dehiscente. Semina cylindrica, pollicaria, testa tenui nigro-brunnea, albumine carnoso, embryone centrali, cotyledonibus lineari-oblongis planis, radicula brevi supera.

"The breaking up of the fruit, as described above, takes place also in water-worn specimens, as shown in the fruit collected by Dr. Nicholls. *Sacoglottis amazonica* was previously known only from Teffe or Egas, on the right bank of the middle Amazon, and from the banks of the Tagipurú, a channel in the delta of the Amazon, where it was collected by Martius. It is recorded from St. Vincent, on the authority of Guilding. Specimens from the latter are in the Kew Herbarium, but whether from wild or cultivated plants is not stated. It is also not certain whether they did not come, as many of Guilding's specimens, from Trinidad."—O. STAPF.

SUMMARY.

The story of this interesting drift-fruit is now told. The record of its occurrence has been traced from the year 1605, when it was first figured and described by Clusius, down to 1764, when it was redrawn by Petiver. For about one hundred and fifty years it was successively described by Clusius, Jonston, J. Bauhin, Hans Sloane, and Petiver. From 1764 until 1884, a period of one hundred and twenty years, it appears to have been entirely overlooked. It was, however, once more brought into notice in the latter year, and drifted specimens were obtained within a short period from Jamaica, the South of England, Barbados, the Grenadines (between St. Vincent and Grenada), and Trinidad. The specimen from the latter island was accompanied by careful drawings made by Crüger in 1861, giving particulars not only of the fruit itself, but also of the leaves and flowers. These when carefully compared with the description and plate in the "Flora Brasiliensis," and with specimens in the Kew Herbarium, left no doubt that the plant yielding the Jamaica drift-fruit is *Sacoglottis amazonica*, Mart. This grows very sparingly in the south-eastern portion of Trinidad, where it was collected by Crüger, but is more abundant in the delta of the Amazon, where it was collected by Martius and others. It is evident that from one or both of these localities the fruits are carried by the waters of the Gulf Stream into the Caribbean Sea, and either thrown ashore on the West Indian Islands, or carried still further, as in the case of many other similar fruits, across the North Atlantic, and cast on the shores of Western Europe. D. MORRIS.

THE PERCEPTION OF LIGHT.[1]

AT a former anniversary I brought before the members of the Institute the subject of the luminiferous ether. It is one of great and growing interest. I mentioned on that occasion how discoveries of very recent date have led us to attribute continually increasing importance, and a widening range of function, to that medium—substance can I call it ?—the existence of which was originally assumed as a hypothesis in order to account for the phenomena of light. It is in connection with this last aspect that it relates to what I propose to bring before you to-day.

The wonderful sense of sight, which, to use an expression of Sir John Herschel's, confers upon us to some extent the character of ubiquity, requires two things: in the first place, some means by which those distant bodies which we see are able to affect our own neighbourhood ; in the second place, some provision in our own bodies for receiving that influence, and transmitting some sensation to the conscious being.

In my former address I considered the first of these two subjects ; to-day I mean to confine myself to the second. This second, even by itself, is, however, far too wide for a single address ; selection of some kind is imperatively demanded. Moreover, there are some parts which are accurately known, and may even be made the object of mathematical calculation, while there are others which not merely lie beyond our existing knowledge, but beyond any that we can hope to attain to, at least in this life. Wonderful as is the construction of the eye in all its parts, so far as relates to the formation of images on the retina it acts simply like an optical instrument, like a telescope or microscope, or, more correctly, like the objective of such an instrument, and we may apply our mathematics to tracing the course of the rays through it. On the other hand, even if we knew accurately—which we do not—the nature of the effect which the external agent produces on the ultimate structure of our bodies, there would still remain, shrouded in impenetrable mystery, the nature of the process by which some change in the bodily organism causes a sensation to the conscious being.

Between these two extremes lies a region which has been to some extent explored, and in which a gradual and perhaps at last a very substantial increase to our existing scientific knowledge may be looked upon as probable. The investigation of this region possesses the keen interest which belongs to the discovery of new truths, and the addition thereby made to the stock of human knowledge. It is to this borderland lying between the well known and the unknown, and to certain parts of the structure of the eye having relation to it, that I would for a short time direct your attention to-day.

As I have already intimated, I propose to pass by entirely the functions of the eye acting as a simple optical instrument in forming images on the retina. The explanation of that may be found in all the ordinary text-books, and I will not weary you by repeating what is there to be found, and which is generally familiarly known.

The phenomena of vision show that distinctness of vision is dependent somehow or other in the first instance on the formation of distinct images of external objects on the retina. In that formation, as I have said, the transparent portion of the eye, the cornea, the aqueous humour, the crystalline lens and vitreous humour, plays the part of a lens in an optical instrument. I have said the "formation of the images on the retina" ; but the retina is not a mere surface, it has a certain amount of thickness, although it is, on the whole, very thin. We may further inquire on what part of the retina, considered at different depths from the place where it first commences, on which of the various layers into which histologists have divided it, is it that we have reason to think that light first acts on the organism of our bodies in such a manner as ultimately to give us the sensation of vision?

I have said that the retina, as a whole, though very thin, is not a mere surface. If we go from the centre of the eye-ball

[1] Presidential Address delivered at the Victoria Institute by Sir G. G. Stokes, F.R.S.

outwards, *i.e.* towards the back of the body, we have first a plexus of very fine nerve-fibres which run along the front of the retina, and ultimately unite in the optic nerve, which runs into the brain. We have also minute blood-vessels, which are essential, apparently, for the growth from its original state, and for the nutrition of the eye-ball, and for the carrying on of the process for which it was designed, viz. that of enabling us to see. Then we have several layers of pulpy transparent substances which have been called ganglions, nuclei, and molecules, mixed with very fine fibres. Some of these are nerve-fibres, others are believed by anatomists to have relation to the fixing of the various parts of the structure to one another, so that they shall not fall to pieces in the rapid motions of the person using the eye.

Outside all, at the back surface of the retina, there is what is called the choroid coat; but between that and the coats I have spoken of is a very remarkable structure which I shall have to say more about. It is called the *bacillary* layer. In this part of the retina we have a vast number of elongated bodies placed closely, side by side. In the human eye, and in the eyes of most animals, they are of two shapes, and have been called accordingly rods and cones. The rods, as the name implies, are cylindrical, and the cones are tapering and are somewhat of the shape of slender peg-tops, the sharp side being turned inwards as regards the way you look, so that the light, in coming from the outside, first meets the bases of the peg-tops, and then goes on towards the point. About the point of these rods and cones, just close to the choroid coat, is a layer of pigment cells which absorb the greater part of the light falling upon them. The rods and cones are transparent, and allow the light to pass through them, passing lengthways. I said the extremities reached to the layer of pigment cells forming a black lining immediately inside the choroid coat. That is true of the rods, but the cones do not reach quite so far, *i.e.* when the eye is in a state of repose, as in darkness; but under the stimulus of light these pigment cells come down, *i.e.* forward, in the direction in which you look, so as to reach the tops of the cones as well as of the rods. I have said that these elements (remember, please, that they point radially in the direction in which you are looking, and lie side by side) are exceedingly numerous. When they are looked on lengthways from the back of the eye when the pigment is removed, they form a sort of mosaic. You may imagine the general structure of them by thinking of the head of the common sunflower in seed. They are arranged side by side, something like the seeds of the sunflower; but they lie so close that the distance between the neighbouring rods or cones, as the case may be, is only about (it varies somewhat from one part of the eye to another) $\frac{4}{1000}$th part of a millimetre, or say about $\frac{1}{6000}$th part of an inch. So numerous are they that a square with sides the tenth of an inch would cover nearly half a million of them.

Now something more about these rods and cones. They are found to be composed of two members or limbs, an inner (nearer the centre of the eye-ball) and an outer. The inner is a transparent-looking body, very much like the other bodies in the neighbourhood. The outer is transparent too; but it is found to be highly refractive. It is longer in the rods than in the cones. The outer segment of the cones may be represented to the mind's eye by thinking of the metallic point of a peg-top. These outer limbs are in both cases readily detached (when the eye is dissected) from the inner, and they separate after a little into laminæ, lying one on the top of the other, perpendicular to the axis of the rod or cone. At the outer end they do not appear to have any continuation, the structure stops. At the inner end (corresponding in the case of the cones with the bulbs of the peg-tops) there come nerve fibres from each of them. These pass through the various layers that I have spoken of; and although the course of them has not actually been traced the whole way, on account of the difficulty of examination of this pulpy structure, it is pretty certain that they join on to those nerve-fibres which line the front surface of the retina, and so pass on, through the optic nerve, to the brain. When I say "pass on" I mean of course as you trace them along; there is no motion in the case. This is a very remarkable structure. Has it any object? What is its object? Now we know by experience that if we have a single point of light exposed to us, the impression is that of a single point of light in the field of view. If there be two such points we have the impression of two luminous points occupying different positions in the field of view. Now two such points may be very close to one another, and yet we still see them as two. It is found that the limit of closeness, beyond which we are unable to distinguish two objects as two, is such that a line drawn between them subtends at the eye an angle of about one minute, or an angle of about $\frac{1}{30}$th part of that subtended by the diameter of the moon. Yet although they exist as close as that, the impression of the two is distinct, and we might have a number of points, each giving a distinct impression. It appears, therefore, that for the purpose of vision it is necessary that stimulations coming from a vast number of independent points, having different bearings from the eye, should, somehow or other, give rise to distinct impressions.

Now if by calculation we trace inwards, to the retina, the course of the axes of two pencils coming respectively from two distant points not far from the centre of the field, it is found that those axes intersect, not exactly in the centre of the eye-ball, but in a point (called the optical centre) a little in front of it, the position of which we can calculate; and the place of either image may be found by joining the external point with the optical centre, and producing the joining line to meet the retina. It is an easy matter now to calculate the distance on the retina of the images of two external points which subtend at the eye a known angle; and it is found that when the external points are so close as only just to be seen as two, the distance of the two images is about the $\frac{4}{1000}$th of a millimetre, just about the distance apart of the cones and rods from one another, lying so closely as I have explained they do. Here, then, it would appear, in this remarkable layer of the retina, we have a provision enabling us to have distinct sensation of a vast number of distinct points in the field of view; and consequently we have reason to suppose that the effect of light, whatever it be, on one of these elements (be it cone or be it rod) gives rise to the sensation of a point; and that the position of that point in the field of view depends upon the position of the element of the bacillary layer which has been affected by the light coming from the point. Moreover in the nerve-fibres which come from the anterior ends of the rods and cones we appear to have a provision for communicating, through the optic nerve, to the brain, the influence, or an indication of the influence which light exerts on one of these elements.

Now I have mentioned one argument for believing that this remarkable bacillary layer is that in which light, which previously merely passed through the eye as it would through an optical instrument, acts in some manner on the organism so as to give rise to stimulation of the nerves which convey to us the sensation of vision. The argument, so far, is a sort of *à priori* one, but it has been remarkably confirmed by an experiment of H. Müller's, made by means of Purkinje's figures.

When in a room which is not quite dark we look with one eye towards a moderately illuminated wall with uniform surface, and holding a candle to one side of the eye move it up and down, there is seen in the field of view a figure branching like seaweed. This is the shadow of the blood-vessels of the retina. That the candle requires to be moved in order to show the figure, is explained by the consideration that the shadow is not black, but only darker than its neighbourhood, and when the light is steady the exhaustion of the eye for that part of the field which lies beside the shadow tends to equalise the apparent illumination of the parts in and out of shadow; whereas when the candle is moved the shadow falls on a new place which had been in full light and therefore partially exhausted, and the previous exhaustion and the new partial interception of light falling on that place contribute to make the shadow sensible.

The existence of a shadow shows already that the percipient layer of the retina must lie behind the blood-vessels. But we may go a step further. By suitable methods of illumination we may cause two spots on the surface of the eye-ball, whose positions can be determined from the circumstances of the experiment, to be alternately virtually the sources of the light which casts the shadow, and the places in the field of view of the shadows of the same vessel in the two positions of the illuminating source can be marked. It is then only a question of similar triangles to determine how far behind the blood-vessels lies the percipient layer, and the distance thus calculated is found to agree, within the limits of errors of observation, with the distance of the bacillary layer as determined by microscopic examination of a dissected eye.

I have said as you go backward from the centre of the eye-ball, you have, in front of the rest of the retina, a plexus, as it is called, of nerve-fibres lying side by side, something like the threads in a skein of silk, but gradually leading onwards to the

optic nerve. Light passes across these, but it does not excite the nerves in passing through them. The nerves are transparent, and the light produces no effect upon them directly. If it did, your whole field of view would be confused, because it is known that when a nerve is excited the sensation is referred to a particular part no matter where the nerve may be affected. Suppose you could isolate, say in the thigh, a particular nerve leading to the great toe, and pinch it without hurting its neighbours, you would feel the pinch not where the nerve is pinched, but in the great toe. So, here, if these nerve-fibres were excited by the passage of light through them, then the sensation corresponding to the excitement of a particular nerve-fibre, which would be that of a definite point in the field of view, would be excited by an external luminous point lying anywhere in the curve in which the surface generated by a straight line passing through the optical centre and intersecting the fibre in question would cut what we may call the celestial sphere, and the correspondence between the subjective points in the field of view and objective external points would be lost. And the fact that the visual nerves are not affected by light which passes across them is further shown by the well-known experiment of the blind spot, where the optic axis passes out of the eye-ball, not in the axis of vision but to one side, towards the nose, so that an object whose image falls on the blind spot of one eye is seen by means of the other.

But now comes a question, and here we enter on uncertain and debated ground—How is it that the nerves are stimulated by the light at all?

We have reason to believe that these rods and cones form the means by which the light, acting on them, causes the stimulation of the nerve. As I have said, they consist of two elements, an inner and outer; the outer from the centre of the eye, *i.e.* the inner as regards the body, being of that remarkable structure which I have described. It has been questioned which of these two elements it is that you are to regard as the percipient organ. I do not know that physiologists have decided that question. I have looked into a paper of Max Schultze's—in fact I have it on the table—and he inclines to the opinion that it is the outer element. Now is there anything in the outer element which can conceivably form a means of stimulation of the nerve, when that element is acted on by light?

I have spoken of the way in which it is composed of laminæ which come to pieces when dissected, after a certain amount of maceration. I do not know whether it may not be rash to say what I am about to say, because I do not know that physiologists have suggested it—it is merely an idea which occurred to myself, so you must take it for what it is worth. I was reading an account of the electric organ of electrical fishes, such as the torpedo. It is a very remarkable organ, occupying a considerable space in these fishes. It has a columnar structure, and the column again consists of laminæ placed one over the other. It has a structure which may roughly be compared to that of the basaltic columns in the Giant's Causeway, only here you must think of laminæ as more numerous and not having that curved surface shown in the Giant's Causeway. Now nobody questions that somehow or other this is an organ by means of which these fishes are enabled to give a shock, and the idea, of course, is suggested, are not these laminæ like the plates of a battery? Is not one of these columns, roughly speaking, something like a galvanic battery? But how the battery is charged and discharged we do not know. In this case it depends, no doubt, on the will of the animal as to what he does, and nobody knows how he brings that about.

Now it strikes me that there is a remarkable apparent analogy between the outer member of the rods and cones, and these columns in electrical fishes. This gives rise to the suspicion that possibly these outer members may act the part of a microscopic battery, being charged somehow or other. But how are they to be charged? Well, before I go on to enter into any speculation on that I may mention that some years ago Prof. Dewar and Mr. McKendrick made some remarkable experiments, the results of which are given in a paper published in the *Transactions* of the Royal Society of Edinburgh. When an eye is dissected out, and the cornea is connected through a wire with non-polarising electrodes to the middle of the section of the optic nerve, the wire being led through a delicate galvanometer, it is found that there is a certain amount of electric current passing. Now it was found that when the eye (having been in darkness) was allowed to have light shining upon it, there was a change in this current, and a change again when the light was cut off. It is true that the total change was only a small fraction of the whole; but still that there should be any change at all produced by the action of light is a remarkable thing. It looks very much as if the stimulation of the nerve had something or other to do with the production of electric currents; but those, if they are produced, we must suppose to be produced in some way by the action of light. How may we imagine light to act so as to produce them? It has been discovered that in the layer of pigment cells in the retina there is a substance, called visual purple, of a purple colour, which is acted on by light, and is made first yellow and then nearly colourless. We have thus a substance that is capable of being acted upon by light, as very many substances are. I do not say that it is by any means proved that that is the substance, or even that there is any substance, which is acted upon by light in the way demanded; yet it seems very probable that the change produced by the action of light, whether it be on visual purple, or some other substance associated with it, may give rise to something which may, so to speak, charge this microscopic battery and stimulate the nerve-fibre which is attached to it. We know the rate of the vibrations of light of various kinds; and the rapidity of vibrations is so enormous, ranging about 400 millions of millions of vibrations in a second, that we can hardly imagine that the organism of our bodies is calculated to be set in vibration in a corresponding period. In that respect the sense of sight differs notably from the sense of hearing. In hearing the tympanum of the ear is thrown into vibration, and the vibrations are not so enormous in number in such a time as one second but that the corresponding nerves may actually be mechanically agitated, and thereby in some way stimulated. We can hardly imagine that the visual nerves are acted upon in this sort of way directly by the luminous vibrations, but they may be indirectly. Here, again, I may throw out a possible conjecture, though I am less disposed to receive it myself than that which I have just mentioned. We know there are substances which when acted upon by light continue to shine in the dark. In some cases the action ceases almost instantly after the exciting light is cut off; for instance, a solution of the salts of quinine, where the rapidity of cessation of the effect is amply sufficient to tally with the rapidity of cessation of visual sensation when light is cut off.

There are various other matters connected with the perception of light which are of great importance to our well-being and to our enjoyment which I have not ventured to touch upon at all. It would take a great deal too long to go into two which I will only just mention. One is the provision in the two eyes, and in the muscles which move them, which enables us to obtain single vision notwithstanding that the two eyes are at work. Nothing is easier than to obtain double vision in which the images seen by means of two eyes occupy different positions in the field of view. There are very remarkable contrivances for bringing about singleness of vision in the habitual use of both eyes.

Then, again, we do not see light merely as light, but we see a great variety of colour. We can distinguish one light from another light by its colour, and not by its intensity only. It would take me a great deal too long to give you any idea of what is known (which after all is not much) as to the way in which that is effected.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Woodwardian Museum has been greatly enriched by the generosity of Prof. T. Wiltshire, Treasurer of the Geological Society and Secretary of the Palæontographical Society, who has presented to the University a large collection of Cretaceous fossils. The collection includes nearly all the known British species, as well as many not yet described. This addition will probably make the Woodwardian collection of Cretaceous fossils the finest in the country. The thanks of the University have been voted to Prof. Wiltshire, who is himself a Cambridge graduate.

Sir William Turner, F.R.S., of Edinburgh, has been appointed an Elector to the chair of Anatomy, and Lord Walsingham, F.R.S., an Elector to the chair of Zoology and Comparative Anatomy, in place of the late Right Hon. T. H. Huxley.

The Vice-Chancellor, Mr. C. Smith, Master of Sidney Sussex College, is suffering from the shock of a fall from his bicycle last week, and will probably be unable to resume his duties for some

time to come. We learn, however, that he is making satisfactory progress towards recovery. The Provost of King's College, late Vice-Chancellor, is acting for him.

DR. A. WEISMANN has been granted the degree of Doctor *honoris causâ* by the University of Utrecht.

Science states that at the annual meeting of the Chicago Alumni of Mount Holyoke College, on October 24, Dr. D. K. Pearson offered to give £30,000 to the College, provided the alumni would raise an additional £10,000.

A MEMORIAL from the London School of Medicine for Women was considered at a meeting of the Council of the Royal College of Surgeons of England, last week, and it was resolved that—"The Council of the Royal College of Surgeons of England, although in favour of granting the petition of the officers and teachers of the London School of Medicine for Women, do not see their way to admit women to the Conjoint Examination in face of the adverse vote of the meeting of the Fellows and Members of this College and the expressed opinion of the Royal College of Physicians."

AT a meeting of the Council of University College, Dundee, on Monday, the question of the relations of the college to St. Andrews University was considered. It was decided to address a letter to her Majesty's Commissioners expressing the willingness of the Council to consider carefully any suggestion from the Commissioners with a view to removing the difficulties in which, by recent events, the University and the college had been placed, and in particular to meet the Commissioners and the University Court to discuss anew any proposals which might form the basis of a new agreement between the two institutions and secure to each the advantages provided for in the Universities Bill of 1889.

THE following are among recent appointments:—Prof. S. L. Barton to be professor of mathematics in the University of the South, Seewanee, Tennessee; Dr. A. Macfarland to be lecturer in physics in Lehigh University; Dr. G. B. van Vleck to be associate professor of mathematics in Wesleyan University; Prof. C. A. Waldo to be professor of mathematics at Purdue University; Prof. K. Zickler to be professor of technical electricity in the Technische Hochschule at Brünn; Dr. R. Dzieslewski to be professor of the same subject at Lemberg Technische Hochschule; Dr. F. Mehres, extraordinary professor of physiology in the Bohemian University at Prague, to be professor; Dr. F. R. von Höhnel to be professor of botany and technical microscopy in the Technische Hochschule at Vienna; Dr. H. Klinger to be professor of chemistry at Königsberg; Dr. E. Waelsch to be extraordinary professor of mathematics in the German Technische Hochschule at Brünn.

A CONFERENCE of the leading teaching and examining bodies of the kingdom and of representative County Councils which are in a position, under the County Councils Act, to contribute funds for the purpose of technical instruction, was held last week, under the auspices of the London Chamber of Commerce, at Drapers' Hall, Sir Albert K. Rollit (President of the Chamber) presiding. The conference agreed to a resolution approving the principle of the co-ordination and simplification of the present system of examinations in commercial subjects, and the matter was referred to the Commercial Education Committee of the London Chamber of Commerce to consider details and formulate a scheme to carry this resolution with effect, it being understood that the Chamber would enlarge its Committee for this purpose by the addition of some members of the conference. Perhaps now that the Chamber of Commerce has taken steps to organise commercial education, it may go on, and, in the course of time, do something for instruction in science.

FROM statistics in the *Deutscher Universitäts Kalender* it appears that the number of persons attending lectures in German universities during the winter semester of 1894-95 was 33,021, of whom 8755 were in attendance at Berlin, 1587 at Bonn, 1350 at Breslau, 1168 at Erlangen, 1216 at Freiburg, 556 at Giessen, 843 at Göttingen, 775 at Greifswald, 1643 at Halle, 1230 at Heidelberg, 667 at Jena, 532 at Kiel, 737 at Königsberg, 3112 at Leipzig, 852 at Marburg, 3561 at Munich, 421 at Münster, 420 at Rostock, 980 at Strassburg, 1184 at Tübingen, and 1492 at Würzburg. At Berlin, however, the matriculated students numbered only 5631, the remaining 3724 being persons who had received permission to attend lectures without being enrolled as *cives academici*; at Leipzig there were 127 of such students, and at Munich only 86. In the law department (including cameralistics and forestry) there were at Berlin 1667, at Leipzig 985, and at Munich 1230 students; in the medical department (including surgery and pharmacy) at Berlin 1220, at Leipzig 752, and at Munich 1168; in the philosophical department (including philology, mathematics, &c.) at Berlin 1660, at Leipzig 856, and at Munich 700.

SEVERAL noteworthy points are referred to in the Report of the City and Guilds Technical College, Finsbury, for the session 1894-95, in addition to the usual statistics and statements as to the number and quality of the students and the work of the different departments. During the session a number of students entered the College with scholarships from various County Councils and other bodies. A few of these were able to obtain the full benefit from the instruction given, but some of them had gained their scholarships when too childish to benefit properly by the College system. Others suffered from imperfect preliminary training, having been crammed to pass examinations rather than trained how to learn. And the result of it all is that the Principal points out that care must be exercised in future, and influence brought to bear upon the educational advisers of the various County Councils as to their selection of scholarship holders. As a step towards the better selection of qualified candidates, it is proposed to introduce a slight modification into the entrance examination of the College. As with other Colleges on the same status, it appears that amongst the newly-admitted students every year there are a number who have never been taught to take notes, to write original descriptions, or even to use indices or books of reference. The presence of these students has been found greatly to retard the general course of teaching, and causes much waste of time. The time of lecturers and demonstrators is taken away from their proper work to teach the new students things which they ought to have learned at school. As a step toward remedying this matter, it is proposed in future to lay more stress upon the English subjects in the entrance examination, by giving them greater prominence, and by assigning higher marks for such as *précis writing* and composition. In concluding his report, Prof. Thompson has something to say about the future of the College. The large Technical Institutes which have sprung up during the past few years, in various parts of London, have affected the trade-classes at the College to a certain extent, and have also diminished the numbers of students attending the elementary classes. But these Institutes have only affected the elementary part of the work, and the indications are that the more advanced students from the elementary work of the Institutes should pass to the Technical College to carry it on. No institution in London is attempting to give in its evening classes instruction of so thoroughly scientific a character as is given at that College; the instruction is, indeed, admirably suited to supplement the work of the various Polytechnics. It is therefore proposed to develop the courses of special lectures given at Finsbury, and to raise the scientific standard of the evening class work, so as to make the College a focus for the higher branches of study, and for more specialised classes than those of the Technical Institutes.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. ii. No. 1, October 1895.—The number opens with accounts of the proceedings at the second summer meeting of the American Mathematical Society, held at Springfield, Mass., on August 27 and 28, and of the proceedings at the meeting of Section A of the American Association, held at the same place, from August 29 to September 4. The papers at each meeting are given in abstract, and two of them are printed in full, viz. on the differential equations of certain systems of conics, by R. A. Roberts, and asymptotic lines on a circular ring, by Prof. Maschke. The results in the former paper are principally deduced by means of elliptic integrals and the first class of hyper-elliptic integrals, and from these are derived theorems concerning doubly infinite porisms of curvilinear polygons. The latter paper contains an application of elliptic functions to curves drawn on the surface of a circular ring.—Prof. F. Morley communicates a short note on a generalisation of Weierstrass's equation with three terms.—The notes contain various items of interest, and the list of publications is unusually full.

The Mathematical Gazette, No. 6, October 1895.—The conics of Apollonius, by the Rev. J. J. Milne, is the paper read by that gentleman at the annual meeting in January last. It contains a full and careful analysis of Apollonius' treatise, putting in evidence what the great geometer says on the subject, and also stating what properties he does not touch upon. The result arrived at is that the ground covered by Apollonius "is very extensive, and many parts of the subject are very thoroughly treated which are passed over in silence in modern text-books." —Proof of Horner's method of approximation to a numerical root of an equation by the properties of algebraical quotients and remainders, by Mr. M. Jenkins, is supplementary to papers read before the Association by Messrs. Langley and Hayward. —Dr. J. S. Mackay gives a further short note on Greek geometers before Euclid. Amongst the geometers slightly noticed are Œnopides of Chios, Anaxagoras, Democritus of Abdera, Hippocrates of Chios and Antiphon.—The notes contain some suggestions in mathematical terminology, by R. F. Muirhead; some trigonometrical identities, by the editor and J. H. Hooker; on Simpson's rule, by Prof. A. Lodge; and on division into classes and homogeneous products, by P. J. Harding.—A few questions and reviews complete a number which is quite up to the previous high standard of the *Gazette*. If this journal were better known, we feel sure it would be more heartily supported than it is by mathematical teachers.

Bulletin de l'Académie Royale de Belgique, No. 8.—On a hydrate of arsenic trisulphide and its decomposition by pressure, by W. Spring. If the specific volume of a compound is greater than the sum of those of its constituents, it should be decomposed by pressure. This has already been verified with cupric-calcic acetate. It is also shown by the hexahydrate of arsenic trisulphide, which decomposes on compression in water or orpiment, and does not require very great pressure. This phenomenon is the converse of the combination of bodies by pressure when the resulting specific volume is smaller.—On a spot recently observed on the surface of Venus, and on the period of rotation of this planet, by M. Schiaparelli. This spot is near the south pole of the planet, and had at the time of writing remained the same for four weeks, so that the period of about twenty-three hours is out of the question.—On the attraction sphere in the fixed cells of the conjunctive tissue, by C. de Bruyne. The author investigates the attraction sphere in the conjunctive cellules fixed in position in the interstitial of the liver and the genital glands of *Paludina vivipara*. He describes its constitution, its shape, its continuity with the cytoplasmic filaments, the character of the medullary zone and that of the centrosomes, which vary in number, dimensions and shape. He then describes the situation of the sphere and its relations to the nucleus, and the constitution of the radial fibres. He concludes, against the views of O. Hertwig and others, that the centrosomes rest in the cytoplasm during the stage of repose of the cellule. The drawings reproduced are a conclusive proof of their presence in the conjunctive cellules at rest.

THE papers in the *Bullettino della Società Botanica Italiana* for July belong exclusively to the departments of descriptive and geographical botany, most of them having special reference to the Flora of Italy.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, November 6.—The Right Hon. Lord Walsingham, F.R.S., Vice-President, in the chair.—Lord Walsingham announced the death of M. E. L. Ragonot, President of the Entomological Society of France, and, since 1887, a Foreign Fellow of the Entomological Society of London. He remarked that M. Ragonot was especially distinguished by his knowledge of the *Phycidæ*, a monograph on which group he had brought out in Russia, and for his amiable personal qualities and the readiness he showed to assist other workers in the identification of species. He said that the loss of M. Ragonot would be greatly felt not only by the Entomological Society of France, but by entomologists all over the world, and that the Council had that evening passed a resolution to the effect that the Secretary should write a letter of condolence to the French Entomological Society on the death of their distinguished President. Colonel Swinhoe also spoke as to the great loss sustained by the death of M. Ragonot, and of the kindness and generosity of the deceased, which he had personally experienced. —Mr. Goss read a letter from Mr. Waterhouse, calling attention to the prospectus of a monograph by Mr. Ernest Green on the *Coccidæ* of Ceylon. A copy of the prospectus and specimen plates were shown, and Lord Walsingham and Mr. McLachlan commented on the importance of the proposed work and the beauty of the plates.—Mr. Stevens exhibited two larvæ, supposed to be those of a species of *Anobium*, which had been damaging oil paintings in his possession; also two specimens of a luminous species of *Pyrophorus*, which he had received alive from the West Indies.—Mr. Adkin exhibited a portion of a collection of Lepidoptera made in Hoy, Orkney, in 1895, including the following species, viz. *Agrotis vestigialis*, *A. tritici*, and *A. cursoria*, not previously recorded from Orkney; *Nemeophila plantaginis*, having the usual yellow ground-colour of the hindwings replaced by red in many of the females; *Hepialus humuli*, males of the ordinary white form, bearing no resemblance to the Unst (Shetland) form; *Triphæna comes*, all very dark, the forewings almost black, the yellow of the hindwings of many of the specimens much obscured by blackish scales; *Noctua festiva*, showing forms of variation ranging between the pale southern and the dark *conflua* forms; *Epunda lutulenta*, some almost uniformly black, others pale grey with dark markings; *Hadena adusta*, one almost black, others much variegated; *Thera juniperata*, many having the central fascia and apical streak very dark brown; and *Hysipetes sordidata*, varying from blackish-brown to pale green.—Mr. Tutt exhibited a series of *Emydia cribrum*, var. *candida*, which he had bred from eggs obtained from a specimen caught by Mr. Merrifield in May 1895, in Northern Italy. He stated that being unable to obtain *Calluna vulgaris*, the ordinary food-plant, he had tried them with Knot Grass (*Polygonum aviculare*), and had no difficulty in rearing them.—The Rev. Canon Fowler exhibited, on behalf of Prof. Poulton, F.R.S., living *Diapheromera femorata* bred from eggs received from Prof. E. B. Titchener, of New York. He stated that the young larvæ had emerged from the eggs in July and August last, and fed on lime. Several pairs had arrived at maturity, and were feeding in cases in the Oxford Museum. —The Rev. J. H. Hocking exhibited a specimen of *Xylina zinckenii*, taken by him at sugar on the trunk of an oak tree, at Copdock, near Ipswich, on September 30 last. It was in beautiful condition, and had apparently only recently emerged from the chrysalis. He also exhibited two specimens of *Xanthia ocellaris* taken at the same time. Mr. Barrett referred to the few recorded chapters of *X. zinckenii* in this country.—Mr. R. W. Lloyd exhibited male and female specimens of *Amara alpina* from Garvell, Perthshire.—Colonel Swinhoe stated that he had, during the past summer, captured four specimens of *Pieris daplidice* at Deal. They were worn, and had probably been blown over from France. Mr. Tutt remarked that he had collected at Deal for many years, but had never met with *Pieris daplidice*.—Mr. Tutt read a paper by Prof. A. Radcliffe Grote, entitled "Notes on the genus *Cidaria*."—Dr. T. A. Chapman read a paper entitled "Notes on Pupæ; *Orneodes*, *Epermenia*, *Chrysocorys*, and *Pterophorus*." Lord Walsingham, Mr. Blandford, and Mr. Tutt took part in the discussion which ensued.

Geological Society, November 6.—Dr. Henry Woodward, F.R.S., President in the chair.—The Serpentine, Gneissoid and Hornblendic Rocks of the Lizard District, by Prof. T. G. Bonney, F.R.S. The author states that in company with the Rev. E. Hill, and in consequence of their work in Sark, he had again investigated the question of the genesis of the hornblende-schists at the Lizard, and was able to overcome the difficulties which formerly withheld him from attributing an igneous origin to the schists themselves, and their banded structure to fluxional movements during consolidation. There also, as in Sark, he found some evidence of this banding being the result, at any rate in places, of a mixture of a less and a more basic material. Additional evidence was given as to the genesis of the granulitic group and its relations to the hornblende-schist. The author maintained that the relations of the serpentine to the granulitic and the hornblendic groups are inexplicable on the hypothesis of an igneous complex, so far as he understood the meaning of that term, or of a folding in a solid condition or any other form of dynamometamorphism, and he maintained his original opinion that the serpentine (*i.e.* the original peridotite) was intrusive in the other rocks. The paper also dealt with some minor points in the geology of the Lizard. In the discussion that followed, Mr. Teall, speaking as to the origin of hornblende-schists, reaffirmed his belief in the theory that both gabbros and basic

dykes had been converted into rocks of this character by dynamic metamorphism; and Sir Archibald Geikie said that though he would not venture to offer an opinion upon most of the disputed questions in the geological structure of that area, he had seen evidence sufficient to convince him that in the Potstone Point part of the coast the serpentine and horblende-schist formed, as Mr. Teall maintained, the great complex which presented a marked coincidence of banding and had been plicated by one common series of movements. He could see no indication of the serpentine being intrusive in the schists.—The "schistes lustrés" of Mont Jovet (Savoy), by Dr. J. W. Gregory. The author gave a history of the controversy as to the age of the "schistes lustrés" of the Western Alps, making special reference to the views of Zaccagna and Bertrand concerning the schists of Mont Jovet. Of these writers, the former maintained that the rocks of the summit of the mountain are old rocks on which the Carboniferous and Triassic strata were deposited unconformably; while, according to the latter author, the rocks forming the top of the mountain were laid down after those which flank it. In his paper the present author gave the results of an examination of the rocks of Mont Jovet recently made by him. He contended that Lory and Zaccagna were correct in identifying the central rocks of Mont Jovet as "schistes lustrés," for this conclusion is supported by their lithological characters and the occurrence of basic igneous rocks of the "pietre-verdi" type associated with them, and is not opposed to their stratigraphical relations. It was further maintained, as the results of the evidence collected by the author, that the schists in question were older than the Trias. The probabilities were in favour of the schists occupying the same relation to the Carboniferous as they do to the Trias; while the close approximation of the schists to the former shows that the schists are not the altered representatives of the neighbouring Carboniferous beds, and it was therefore concluded that the "schistes lustrés" are pre-Carboniferous, but evidence by which finally to assign them to any exact horizon before this date is still wanting.

Linnean Society, November 7.—Mr. C. B. Clarke, President, in the chair.—Several volumes of Cryptogamic exsiccata, recently received from Madame Weddell as a bequest from her late husband, a foreign member of the Society, were shown, and some remarks made thereon by the Botanical Secretary.—A portrait of the French naturalist Guillaume Rondelet, Professor of Anatomy and Chancellor of the University of Montpellier 1545, recently presented to the Society by Dr. H. Woodward, F.R.S., was exhibited by the Zoological Secretary, who gave an account of his life and work, supplemented by remarks from the President.—Mr. C. T. Druery exhibited and made remarks on a *Scolopendrium* raised by Mr. E. J. Lowe, bearing archegonia and antheridia upon the fronds, constituting a more advanced phase of apospory than any previously noted. Some remarks thereon were made by Mr. George Murray.—Dr. Maxwell T. Masters exhibited specimens of the fruit of *Pyrus sorbus*, *Aberia caffra*, and small *Cocos australis*, from the gardens of Mr. Thomas Hanbury at La Mortola, Mentone, and some palm fruits of *Cocos australis* from Naudin's garden at Antibes, Alpes Maritimes.—Mr. J. E. Harting exhibited a specimen of the American yellow-billed cuckoo, which had been picked up dead in a garden at Bridport, Dorsetshire, on October 5, and gave some account of the species and previous occurrence in the British Islands.—A paper was read by Colonel Swinhoe on mimicry in butterflies of the genus *Hypolimnas*, Hübner. By means of a series of beautifully coloured lantern slides, he showed the changes in mimetic forms in a single genus of Nymphalid butterflies, from India through Arabia to Africa, and from India through the Malay Archipelago to Australia, commenting upon the resemblance they always bear in colour and pattern to different forms of *Danaïs* and *Euplœa*, insects well known to be distasteful to birds and reptiles.—Mr. G. F. Scott Elliot communicated a paper entitled "A revision of the genus *Pentas*," in which some account was given of the distribution of these plants in Africa, with a rectification of the synonymy, and descriptions of five new species. The genus as a whole showed in a remarkable manner the way in which local species occur whenever a different climate restricts the distribution of a wide-ranging form, and several examples of this were mentioned. A discussion followed, in which the President and Mr. W. P. Hiern took part.—On behalf of Dr. A. G. Butler, an abstract was read of a paper on butterflies of the genus *Charaxes*, of which 159 species were recognised, nearly all of which are represented in the National collection. Five species—*Charaxes princeps*, *C. repetitus*, *C. layardi*, *C. fervens*, and *C. coniger*—were described as new.

PARIS.

Academy of Sciences, November 11.—M. Marey in the chair.—The following memoirs have been submitted to Committees: "Comparison of the French, English, and German races by means of mortality tables," by M. Delauney. A note concerning the weight of the atmosphere, by M. F. Delmas. "On the formation of curved refractors and reflectors by means of plane mirrors and transparent plane surfaces," by M. Moret de Montjou. "The defence of the vine against phylloxera," by M. Leroux (Tenès, Algeria). "A contribution to the study of ferments," by MM. G. Nivière and A. Hubert. "The Cartesian planimeter with tangential registration. A new mechanical integrator of great precision," by M. José Ruiz-Castizo.—On a problem concerning the determination of the integrals of an equation to the derived partials, by M. E. Goursat.—On the unicursal types of two dimensions, by M. Léon Autonne.—On the homogeneous differential linear equations of which the general integral is uniform, by M. G. Floquet.—On the construction of new magnetic maps of the globe, undertaken under the direction of the Bureau des Longitudes, by M. de Bernardières. Seven survey expeditions have been equipped with the most modern appliances, and sent, under competent observers, to ascertain accurately the magnetic elements at numerous stations, and an eighth will be started as soon as the necessary instruments are obtained. The observing stations are grouped broadly round the great oceans.—Some effects of the synodic revolution of the moon on the distribution of pressures in the season of summer, by M. A. Poincaré.—On the hardening of extra-hard steels, by M. F. Osmond. With steels containing 0·35 to about 1·3 per cent. of carbon there is a gradual increase of hardness with increase of carbon contents, beyond 1·3 per cent. the steel becomes softer. A description is given of the method of investigating the structure of steel by abrasion with a sewing needle and microscopic examination of the scratch, and it is shown that the structure thus investigated leads to the conclusion that hard steels consist of two interpenetrating types of steel, of which one is much harder than the other. The same conclusion may be drawn by examination of etching figures, using iodine tincture or dilute nitric acid for the attack.—On the silicides of nickel and cobalt, by M. Vigouroux. These compounds of silicon and nickel or cobalt are produced in similar ways to the chromium and iron silicides. They have the composition $SiNi_2$, $SiCo_2$. They have a steel-grey metallic appearance, a specific gravity of about 7·1, and are more fusible than either of the constituents. Their properties in relation to halogens, halogen acids, oxygen, alkalies, and potassium nitrate are given in detail.—On crystallised normal calcium chromite, by M. E. Dufau. At a sufficiently high temperature, chromic oxide combines directly with lime to give a chromite of the composition $CaO.Cr_2O_3$. This compound is stable at the highest temperatures. It forms prismatic needles of metallic lustre, transparent in thin crystals, and of a fine green colour. Its hardness is 6, and specific gravity 4·8 at 18°.—On the alcoholates, by M. H. Lescœur. Sodium ethoxide forms no stable alcoholate, sodium hydrate appears to give the compounds $NaOH.3C_2H_6O$ and $NaOH.C_2H_6O$.—On the properties of emulsin from mushrooms, by MM. Em. Bourquelot and H. Hérissey. Emulsin from different fungi of the mushroom type appears always to be the same, and it cannot be affirmed to differ from the emulsin of almonds.—Constancy of the freezing point of some liquids of the organism. Application to the analysis of milk, by M. J. Winter. The author establishes the isotonism of body-fluids, more particularly of milk and blood-serum. "These liquids are equimolecular, and their molecular concentration is the same among the diverse animal species examined." The constancy of the freezing point of milk may be used as a means of detecting adulteration with water. Blood-corpuscles, along with their other functions, serve the purpose of regulating the concentration of the blood serum.—On fermentations caused by Friedländer's pneumobacillus, by M. L. Grimbert. There exist two types of Friedländer's pneumobacillus which are morphologically alike, but differ in their fermentative action. The pneumobacillus studied by Frankland has no action on glycerol and dulcitol, whereas that from the Pasteur Institute attacks these substances.—On the direct fixation, by vegetable fibres, of certain metallic oxides, by M. A. Bonnet.—On the detached crystalline rocks, probably of Tertiary age, in the Briançon Alps, by M. P. Termier.

NEW SOUTH WALES.

Linnean Society, September 25.—Mr. Henry Deane, President, in the chair.—Notes on Cicadas, by W. W. Froggatt.—Description of a tree creeper presumably new, by C. W. De Vis, *Climacteris animosa*, n.sp. Several examples were obtained in clearings in the Mulga Scrubs, at Charleville.—On the dates of publication of the early volumes of the Society's Proceedings, by J. J. Fletcher.—The President exhibited a number of botanical specimens from the Tweed River.—Mr. Froggatt exhibited his collection of Sydney Cicadas.—Mr. Steel showed a Gecko (*Gehyra vorax*, Gir.) from the Rewa River, Fiji.—Mr. Fletcher showed some English humble bees, the defunct portion of a consignment from New Zealand, recently imported by the Department of Agriculture in the hope of the successful acclimatisation of the insects. Of the remainder, some were liberated in the Botanic Gardens, and some in the Society's arden.

BERLIN

Meteorological Society, October 15.—Prof. Hellmann, President, in the chair.—Dr. Kassner spoke on the influence of weather on the growth of sugar-beets. He had compared the beet-root crops in the provinces of Saxony and Silesia, with the temperatures, rainfall, and intensity of rain during fifteen years, for the yearly period from October 1 to September 30. The curves of temperature corresponded to those of the crops in both provinces, except in 1887. On the other hand, the curves of rainfall in Silesia showed no such correspondence, although they were in somewhat greater harmony in Saxony. The curves of intensity of rain were in somewhat closer accordance with those of the crops, than were the curves of rainfall. The speaker came to the conclusion that the relationship of weather to crops requires a much more thorough investigation than is possible with the scanty data as yet available.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—(1) On the Gases obtained from the Mineral Eliasite. (2) On the New Gases obtained from Uraninite. Sixth Note. (3) On the Variable Stars of the δ Cephei Class: J. Norman Lockyer, C.B., F.R.S.—Microscopic and Systematic Study of Madreporarian Types of Corals: Miss Maria M. Ogilvie.—On the Calibrationof the Capillary Electrometer: G. J. Burch.—An Experimental Investigation of the Laws of Attrition: F. T. Trouton.—Experiments on Fluid Viscosity: A. Mallock.

LINNEAN SOCIETY, at 8.—Development of a Single Seed in the Fruit of the Cocoanut Palm (Cocos nucifera): D. Morris, C.M.G.—Assimilation in Plants under Abnormal Conditions: A. J. Ewart.—On a New Species of Pinites from Wealden (England): A. C. Seward.

CHEMICAL SOCIETY, at 8.—The Evolution of Carbon Monoxide by Alkaline Pyrogallol Solution during Absorption of Oxygen: Prof. Clowes.—The Composition of the Limiting Explosive Mixtures of various Combustible Gases with Air: Prof. Clowes.—Barium Butyrate and the Estimation of Butyric Acid: W. H. Willcox.—And other Papers.

LONDON INSTITUTION, at 6.—Relation of Ants to Plants: Prof. F. E. Weiss.

CAMERA CLUB, at 8.15—Mechanical Carriages: J. H. Knight.

SOCIETY OF ANTIQUARIES, at 8.30.

NUMISMATIC SOCIETY, at 7.

FRIDAY, NOVEMBER 22.

PHYSICAL SOCIETY, at 5.—An Exhibition of Photographs of Spectra: G. Johnstone Stoney.—A Direct Reading Platinum Thermometer: R. Appleyard.—Historical Note on Resistance and its Change with Temperature: R. Appleyard.

CLINICAL SOCIETY, at 8.30.

SATURDAY, NOVEMBER 23.

ROYAL BOTANIC SOCIETY, at 3.45.

MONDAY, NOVEMBER 25.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Faëroe Islands: Dr. Karl Grossmann.

INSTITUTE OF ACTUARIES, at 7.—Address by the President, Mr. Alex. J. Finlaison, C.B., on the Recent International Congress of Actuaries at Brussels.

MEDICAL SOCIETY, at 8.30.

CAMERA CLUB, at 8.15.—Daylight Enlarging: F. Seyton Scott.

TUESDAY, NOVEMBER 26.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photo-ceramics. A Demonstration will be given by Mr. W. Ethelbert Henry.—A Method of Carbon-printing without Transfer: Valentine Blanchard.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Discussion on Subaqueous Tunnelling by Shield and Compressed Air.

ROYAL VICTORIA HALL, at 8.30.—The Land of the Midnight Sun: Prof. Clowes.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.

WEDNESDAY, NOVEMBER 27.

SOCIETY OF ARTS, at 8.—Locomotive Carriages for Common Roads: H. H. Cunynghame.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, NOVEMBER 28.

ROYAL SOCIETY, at 4.30 (Extra Meeting).—The following Papers will *probably* be read:—Mathematical Contributions to the Theory of Evolution. III. Regression, Heredity, and Panmixia: Prof. Karl Pearson.—The Expansion of Argon and of Helium as compared with that of Air and Hydrogen: J. P. Kuenen and W. W. Randall.—On the Percentage of Argon in Respired Air: A. Kellas.—Examination of Gases from certain Mineral Waters: A. Kellas and Prof. Ramsay, F.R.S.—On the Granular Leucocytes: G. L. Gulland.—On the Development of Lichenopora verrucaria, Fabr.: S. F. Harmer.

LONDON INSTITUTION, at 6.—A Forest Primeval: Prof. W. Boys Dawkins, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electric Wiring Question: F. Bathurst.—Concentric Wiring: Sam Mavor.

SOCIETY OF ANTIQUARIES, at 8.30.

SATURDAY, NOVEMBER 30.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—British Birds' Nests: R. Kearton (Cassell).—Text-Book of the Embryology of Invertebrates: Drs. Korschelt and Heider, translated, Part 1 (Sonnenschein).—Royal Natural History, Vol. 4 (Warne).—A Laboratory Course in Experimental Physics: W. J. Loudon and J. C. McLennan (Macmillan).—Outlines of Psychology: Prof. O. Külpe, translated by Prof. E. B. Titchener (Sonnenschein).—Recettes de l'Electricien: E. Hospitalier (Paris, Masson).—Evolution in Art: Prof. A. C. Haddon (Scott).

PAMPHLETS.—Manchester Museum, Owens College, Museum Handbooks: Catalogue of the Hadfield Collection of Shells from the Loyalty Islands: J. C. Melvill and R. Standen (Manchester, Cornish).—The Ethnology of Buchan (Peterhead).

SERIALS.—Strand Magazine, November (Newnes).—Records of the Australian Museum, Vol. 2, No. 6 (Sydney).—Psychological Review, November (Macmillan).—Transactions of the Rochdale Literary and Scientific Society, Vol. 4 (Rochdale).—Journal of Conchology, January, April, July, October (Dulau).—Synoptical Flora of North America, Vol. 1, Part 1, Fasc. 1: Gray, Watson, and Robinson (Wesley).—Himmel und Erde, November (Berlin).—Royal Natural History, Part 25 (Warne).

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THURSDAY NOVEMBER 28, 1895.

THE "TIMES" ON THE SCIENTIFIC SITUATION.

WE rejoice that at last the daily press is beginning to see the necessity of the State action which we have been preaching for some years to prevent as far as possible the ruining of many of our industries threatened by the development of scientific research and processes in other countries.

Yesterday the *Times* spoke out with no uncertain sound in connection with the often repeated cases in which, in various foreign markets, English are being replaced by German goods. The paragraph to which we refer runs as follows :—

"Our Berlin correspondent called attention two days ago to the immense strides made by German industry during the last quarter of a century, and to the failure of our Government to pay any adequate attention to a development so closely concerning British interests. In this commercial age this industrial nation has one commercial Attaché in Paris who is supposed to keep an eye upon all Europe, and one at St. Petersburg who has all Asia for his province. A commercial Attaché at Berlin for Germany alone would find ample occupation and would furnish knowledge of things that deeply concern us, which it may be feared neither the Government nor the mercantile classes of this country possess at present. We also require urgently a commercial Attaché with especial qualifications for the Far East. Yesterday our Paris correspondent informed us that on his first appearance as Minister for Foreign Affairs M. Berthelot asked money for the establishment of six new consulates in China. The contrast is sufficiently striking between the policy of the two countries, and the difference runs through the entire treatment of the material interests of the two peoples. Both in Germany and in France it is held an essential part of the duty of the State to second, and not only to second, but to stimulate and direct the efforts of private enterprise. In this country, though State interference with commerce is being carried to a dangerous length, State assistance, even in the way of collecting information, is regarded with stupid distrust and disfavour. Our home industries themselves in many cases languish for want of intelligent direction. Our agricultural distress might be alleviated were the State not far above the education of the population in the minor agricultural arts, and the organisation of agricultural industries after the manner in vogue on the Continent. In the same way, although nothing can excuse the short-sighted folly of our manufacturing classes in not providing for scientific research in the various branches of industry, yet it is the duty of a wise Government to take measures to counteract the folly of classes when it threatens the general interest. In one word, Great Britain stands at this moment in imminent danger of being beaten out of the most lucrative fields of commerce, simply because it does not recognise, while other nations do, the value of scientific organisation in the field, in the workshop, in the laboratory, and in the conduct of national policy."

The development of this question at the present moment, on the very day when the public meeting to promote a memorial to Huxley was held, reminds us how much we have lost—how much weaker we are for his absence. Never was Huxley more emphatic than when he pleaded, years ago, for the organisation of our scientific forces, so as to secure the victories of peace. It is now certain that we have lost many of these peaceful battles, and that we shall lose more, because our legislators have either not read the signs of the times, or have been led by those who, if they were consistent, would bring back our Navy to its state in Queen Elizabeth's time, when it was the outcome of individual and local effort.

It is encouraging to think that when the attention of the commercial classes has been drawn to what is happening, as it must be before long, and when the public will possess full knowledge of the utter chaos of our public departments in all things appealing to the national life, so far as it depends upon commercial enterprise under the existing conditions, some action must be taken. We have Committees of the Privy Council for this and that and the other departments, but where are the Scientific Privy Councillors? Where are the meetings held at which they give the State the benefit of their knowledge? In what record do we find the minutes of such "My Lords" as these?

It is not fair even to the administrators of the several departments that the present state of things should be allowed to exist. Too few of these have been chosen on account of their scientific knowledge, and as each question arises they have to pick up their information as best they can. There are several ways of doing this, one of them exhibited by the Board of Trade inquiry last week into the revised regulations referring to the Electric Lighting Acts. The Conference showed conclusively how much the Department gained by the free imparting of knowledge by outsiders.

But this is only one direction in which reforms are needed. The Chambers of Commerce throughout the country must sooner or later take the matter up; and when this is done, many other ways of abolishing the existing chaos will suggest themselves. Some of them we may refer to on a subsequent occasion.

EARTH-WORMS AND STREAM-WORMS.

A Monograph of the Order of Oligochæta. By F. E. Beddard, M.A., F.R.S. Pp. 769, 5 plates, and woodcuts. (Oxford: Clarendon Press, 1895.)

IT seems, at first sight, somewhat curious that such common animals as earthworms, occurring as they do all over the globe, should have received so little attention from zoologists until recent years: yet the neglect is not really to be wondered at, for earthworms are very much alike, and are only distinguishable from one another with difficulty even by a zoologist, while to the non-scientific traveller, collector or settler—to whom students of other classes of animals owe so great a debt—earthworms present no attractive character of form, and rarely of colour. Their subterranean habits, too, protect even brilliantly coloured, or specially large, species from the keen eye of the collector. Some of these worms reach a length of four feet, others are less than an inch; whilst most are uninterestingly coloured, there are some bright ones. *Megascolex cæruleus* is a beautiful peacock blue, *Microchæta rappi* is olive green, and pink below.

Notwithstanding their general unattractiveness, it might have been expected, however, that professional zoologists would have been acquainted with the anatomy of foreign earthworms long before the Franco-Prussian war; yet the first description of the internal organisation of a worm, recognised as being different from our European earthworms, only dates from 1868. About the time of this war, M. Perrier was preparing an account of the anatomy of nine new genera from various parts of the world, which were in the museum at Paris. After the publication of this memoir, in 1872, we have a gap of more than ten years, ere the number of foreign genera was increased; then, in 1883, Mr. Beddard described *Typhæus* from India. But from 1880 onwards, a constantly increasing number of contributions to the anatomy of the group has been published, so that, while in 1884 the bibliography in Prof. Vejdovsky's valuable monograph contains 283 references, that just published by Mr. Beddard refers to more than 650 memoirs.

In the handsome monograph under notice, Mr. Beddard treats his subject in a different manner from that followed by the Bohemian naturalist, who, to a very great extent, confined himself to those species which had come under his own observation. The present author, however, while bringing together facts collected by himself during the past fifteen years, deals fully with the researches of other zoologists. Vejdovsky paid more special attention to the aquatic forms; Beddard gives an adequate account of the entire group of Oligochæta. His work opens with a clear and excellent account of the general anatomy of the group, an account not overburdened with unnecessary detail, but yet containing discussions on many important points of morphology. This chapter should be of the greatest value to the general zoologist, who has long been in need of such an authoritative summary; for the group usually receives but scant attention from him, as after a detailed account of the anatomy and development of the British earthworm (to which, by-the-by, he frequently gives a wrong name), he leaves the rest of the earthworms as if they were not. Yet at least seventy-five genera of earthworms are known, some of which contain 100 species; and even in Britain we have as many as sixteen species, belonging to four genera.

In this anatomical chapter the author gives a very detailed and comparative account of the structure usually known as "prostate" or "atrium," which is generally connected with the end of the sperm duct; he suggests the term "spermiducal gland," which is in every way a useful and distinctive name. These structures have already received discussion at the hands of himself and others, and in the present book he essentially agrees with a view put forward by myself some time ago, though he misunderstands my views as to the Eudrilidæ. He is wrong in his statement that there is no peritoneum surrounding the "cement gland" of Tulificids, for I have figured this in the case of *Heterochæta*. He adopts the view, in which I quite agree, that the spermiducal glands have been derived from structures, such as occur in *Microchæta* and *Kynotus*, entirely independent of the sperm duct, with which they have, in most cases, become secondarily connected.

The monograph, unlike Vejdovsky's, gives a diagnosis of every known species of Oligochæta, both aquatic and terrestrial, which has been described in sufficiently recognisable terms; consequently, the book is invaluable to the specialist and to museum curators. The only member of the class which we miss is that peculiar leech-like parasite on the gills of crayfish, *Branchiobdella*. This has long been recognised as an Oligochæte, and it is not clear why Mr. Beddard has omitted it.

The chapter dealing with the classification and phylogeny of the group contains much that is of interest, and is by no means the "dry bones" that a systematic work frequently is. The class is divided into three "groups" of equal value (1): the Aphanoneura, for the genus *Æolosoma*; (2) the Microdrili, or aquatic worms and Moniligastridæ; (3) the Megadrili, or earthworms. Each of the latter "groups" (to which he does not give a technical term) he divides into families, some of which are grouped to form "superfamilies." But I cannot altogether agree with him in this primary subdivision. It is true that in 1890 (*Quart. Jour. Micr. Sci.*) I suggested the terms, Megadrili and Microdrili, much in the same sense as he uses them; but more recently I have been led to adopt Vejdovsky's opinion, viz. that all earthworms (except *Moniligaster*) form one family, and are to be contrasted with each (not all) of the families of water-worms. Beddard endeavours (on pp. 158 and 171), rather laboriously, it seems to me, to define these two "groups," but the Moniligastridæ have always been a stumbling-block, and Prof. A. G. Bourne's recent memoir (*Quart. Jour. Micr. Sci.* xxxvi.) tends to emphasise rather than to diminish the difficulty; for the clitellum of *Moniligaster*, on which Beddard lays much stress, is there described as being quite like that of an earthworm, and not like that of a water-worm.

Mr. Beddard's careful analysis of the affinities of the various families to one another, and, in later chapters, of the inter-relations of the genera, is a distinctive feature of this monograph, and he calls to his aid the facts from geographical distribution to support his contention that the Perichætidæ are the most archaic earthworms. The primitive arrangement of the bristles in earthworms was,

according to him, a circle round each segment; by reduction, the more usual number, eight, has been brought about. He refers to *Anisochæta* (which, by-the-by, we find on turning to the systematic part of the work, only a synonym for *Megascolex* sp.), a perichæte with only eight bristles on the anterior segments, as a step in this process, which in certain normal octochætous forms, may go so far as to cause the entire disappearance of bristles from the anterior segments. Since the monograph was in press, Prof. Bourne has published (*Quart. Journ. Micr. Sc.* xxxvi.) an account of the development of the bristles in the embryo of *Perichæta*, which rather tends to support the view, that the primitive number was eight, and that the perichætous condition is due to the appearance of additional bristles; and the fact that a circle of bristles occurs in another family of earthworms, as well as in certain Polychætes, also makes against Beddard's views.

Another phylogenetic point of special interest is that of the nephridia. Beddard and others have held that the "plectonephric" or "micronephric" condition is antecedent to the "meganephric"; but the ontogeny of three distinct genera contradicts this view, which Beddard, evidently with reluctance, now gives up. I quite agree with him and others, that my group "Plectonephrica" is artificial.

But while regarding the perichætous condition as archaic amongst earthworms, he places at the base of the whole Oligochæte tree (p. 173) a genus, *Phreoryctes*, in which there are usually only *four* bristles in each segment. Mr. Beddard recognises the difficulty of his position, but does not meet it in a very convincing manner. The facts of the geographical distribution of the earthworms are of great general importance, for the worms and their cocoons will not withstand prolonged immersion in sea-water, and modes of transference are few; the cocoons, being buried deep in the earth, are not likely to be carried on the feet of birds. "The characteristic earthworms of New Zealand are Acanthodrilids; the same family is equally characteristic of Patagonia and the adjacent islands; the only known earthworms from Marion and Kerguelen islands belong to the genus *Acanthodrilus*. These facts seem to me to be sufficiently important to require the formation of an antarctic region circumpolar in extent"—though it would not necessarily include the Cape. Australia is more closely allied to the oriental region (p. 154) than one would have suspected.

We may heartily congratulate Mr. Beddard on this able and readable monograph which he has found time to write, in addition to publishing many papers on other subjects in connection with his work as Prosector to the Zoological Society; and we may also offer our thanks to the Clarendon Press for undertaking this work. The book consists of 725 quarto pages of text, together with 85 pages of bibliography, and a full index (from which, however, we miss *Anteus*); there are five lithographed plates, and numerous illustrations in the text; it is well printed, with wide margins, and simply but effectively bound. But, while offering our congratulations, we must also record a grumble; for there are one or two omissions which detract from the usefulness of the work, from a systematist's point of view. (1) A tabular statement of the classification adopted, would have rendered his views more clearly and more readily than having to weed it out of the text: (2) a synopsis of differential family characters in tabular form, such as we find in the recent Catalogues of the British Museum, would enable one to refer an earthworm to its family with comparative ease. Tables of generic characters there frequently are; but they are often so ill-arranged as to be of comparatively little use. Some of these tables extend across two entire pages of fifty lines or more, and it is extremely difficult for the eye to follow these lines across the wide margins of the two pages (pp. 532–533), especially when, as in p. 632 of my copy, the pages are so bound that the lines do not correspond. This matter might have been so easily remedied by numbering the lines on each page.

Lists of the genera recognised as good, are usually given after the discussion of the family characters; but in some cases, as in Perichætidæ, the list does not appear.

The number of plates seems very inadequate to the text, and it is not evident what plan has been followed in selecting the species figured to illustrate the vascular system, for example; for not one of the figures pretends to give a complete plan of the system, and the chief types even are not represented. Plate v. will remain a mystery to many readers. The diagrams of the reproductive organs, which are on the plan adopted by me in my "Attempt to Classify Earthworms," might have been, with advantage, increased in number so as to include every family.

Such interesting matters as the encysted *Æolosom*, and the peculiarly modified genital setæ of Acanthodrilids, might well have been illustrated.

In such an extensive work as this, misprints and smaller errors can scarcely be excluded, but they are very rare; nevertheless, we think that all measurements should have been given in the metrical system. Here and there one finds "inches" cropping up (*Geoscolex maximus*); and sometimes, where the original measurements were in inches, the transformation to millimetres has been worked out wrongly (*Plagiochæta*).

But with all its faults, the monograph redounds to the credit both of the author and the publishers, and is a most welcome addition to our zoological standard works.

W. B. BENHAM.

DYNAMICS.

Dynamics. By P. G. Tait, M.A., Sec. R.S.E. Pp. 361. (London: Adam and Charles Black, 1895.)

THE main substance of Prof. Tait's present work has, for the past twelve years, been accessible to any one who cared to be at the trouble of consulting the cumbrous volumes of the "Encyclopædia Britannica," but we are glad that the author has at last been induced to issue his article on "Mechanics" in the form of a compact and handy octavo volume. This will be a useful addition to the library of every teacher who has to lecture to advanced classes, but the very encyclopædic treatment of the subject makes it rather hard to judge how far Prof. Tait's work meets the requirements of students. The author

himself says in the preface that "in teaching, I have found it advantageous to supplement the work at each stage by additional examples of the processes given in the text; as well as by references to special books in which particular questions are examined with greater detail." Considered as a synopsis of the principles of statics, particle and rigid dynamics, hydrodynamics, and even portions of elasticity, the book may safely be recommended either to mathematical students, or to such students of physics or engineering as have undergone the necessary preliminary grounding in higher analytical methods.

In its new form, Prof. Tait's "Dynamics" might be not inaptly described as a "Thomson and Tait for Beginners," and in scope and plan it is not very different from Ziwet's American treatise on "Theoretical Mechanics." It opens with a short introductory chapter on Newton's laws, followed in chapter ii. by over 80 pages devoted to pure kinematics, under which heading the analysis of strain receives a fair share of attention. Chapter iii. opens with a few further definitions relating to the laws of motion, chiefly extracted from "Thomson and Tait," followed by an outline of statics of a particle and the theory of attractions, including Green's theorem and the method of electrical images; the whole being condensed into 36 pages. Chapters iv. and v. deal with particle kinetics, and include 14 pages on the principle of least and varying action, and 6 pages on Lagrange's generalised equations. Statics and kinetics of a rigid body follow next, then a short chapter on the dynamics of a chain, in which vibrations of strings occupy only 7 pages. After this comes a still shorter chapter containing a few of the simpler applications of the theory of elasticity. In chapter x. the fundamental equations of hydrodynamics are disposed of in 25 pages, and are followed by a chapter on waves, based on Prof. Tait's "Encyclopædia" article on the subject. The author concludes with a short philosophical discussion on the "objectivity of force."

Unlike the ordinary run of text-books, this one contains no collections of examples, but in most of the worked-out problems, only the main results are stated, so that the reader will find plenty of work to do in filling up the gaps. Perhaps this plan will afford as good or better training than the usual routine of "bookwork and riders." There is a further advantage in the elimination of unnecessary formulæ from the text. The judicious use of small type has also done much in making the mathematical portion appear less formidable, and the use of dark type has been avoided by adopting the method of indention.

A reviewer naturally turns his attention sooner or later to the sections which deal with the laws of motion, and these cannot be said to be above criticism. The recognition of Newton's scholium to the third law as a separate dynamical principle is good, but we should have been glad to have seen greater definiteness in dealing with the second law. We all know that "quantity of motion" is to be interpreted as momentum, but Newton makes no mention of *time* in his statement, and modern text-book writers have remedied the deficiency by restating the second law in the following three different ways:

(1) *Rate of* change of momentum is proportional to the force.

(2) Change of momentum *in a given time* is proportional to the force. (In other words, change of momentum varies as the force when the time is kept constant; the fact that it varies as the time when the force is kept constant, being regarded as too obvious to require stating as a law.)

(3) Change of momentum is proportional to the *impulse* of the force, *impulse* being defined as the time-integral of a force.

Now, Prof. Tait appears to regard the law from the second standpoint on page 8, and from the first on page 100, and yet reference to the "Principia" suggests that the third interpretation is the most strictly Newtonian, since Newton evidently regarded *force* as capable either of being impressed gradually, or of being concentrated about a single instant of time. A statement of Prof. Tait's real views would have been far more acceptable than the series of definitions of "change of momentum," "rate of change of momentum," "rate of change of kinetic energy," "space-rate of change of it," with which chapter iii. opens. If a *rate* had been defined generally, these definitions would be superfluous.

In § 118 we are told that "the second law gives us the means of measuring force, and also of measuring the mass of a body." We had always thought (and still think) that the *third* law is required before *both* force and mass can be measured. For in comparing two forces, Prof. Tait supposes them applied in turn to the same body. But this test affords no criterion of the equality of two forces when applied to different bodies, as they have to be in comparing the masses of the bodies. If we assume an independent definition of equal forces (as, for instance, in Prof. Tait's illustration on p. 111, where he assumes that the same locomotive exerts approximately the same pull on two different trains), the second law, of course, affords a means of comparing two masses, but not otherwise.

We are sorry that Prof. Tait has not altogether banished from his book that highly misleading and artificial phraseology of "a point having several simultaneous velocities" in connection with the parallelogram law (§ 117). Combined with the definition of *velocity* as "rate of change of position," this always *seems* to suggest the (absurd) notion that the point moves into, and therefore occupies, different positions at the same instant. All that the parallelogram of velocities really proves, and what Prof. Tait proves in §§ 30, 31, is that if the velocity of A relative to B and the velocity of B relative to C are represented by two sides of a parallelogram, the diagonal represents the velocity of A relative to C. In passing from this to the parallelogram of forces, the discontinuity of reasoning could perhaps be overcome by a reference to Newton's commentary on his second law, which states that the effect of several forces is the same whether they be impressed simultaneously or successively.

In § 108 the author defines as "the 'component' of a force in any direction" what is now, with great advantage, usually called the *resolved part* of the force in that direction.

We should also like to see the use of the word "stress" avoided in connection with Newton's third law (§§ 174, 352), until some definite understanding has been arrived at as to whether the term is to signify a force, or (like

pressure) a quantity of the dimensions of force divided by area; but, after all, we have had to put up with ambiguities of this kind for so long, that the matter is of no great consequence to the class of readers for whom Prof. Tait's useful little book is intended. G. H. B.

OUR BOOK SHELF.

The People of the Moon. By Tremlett Carter. Pp. 402. (London: The *Electrician* Printing and Publishing Co., Ltd., 1895.)

THIS remarkable book bears upon every page evidence of scientific knowledge and vivid imagination. It is not simply a story of a journey to our satellite—that idea has been worn to threads since Jules Verne used it for the ground-plan of his novel—but purports to be a translation of a volume written by a lunar inhabitant, and sent to the earth. More than one ingenious individual has sapiently suggested that the side of the moon remote from us is inhabited; and as we are not likely to obtain any information on the matter, every one is free to indulge in that belief. The idea that there are living beings in the moon's interior, is of a similar harmless character, and the author of this book has made the most of it.

Down in the interior of the moon, and near the centre, dwelt a race of people—the Sarâva—who believed that the universe was an illimitable extent of solid rock, honeycombed throughout with endless tunnels and caverns. But a man arose—a lunar Copernicus—who propounded the doctrine that the place which the Sarâva occupied was merely a lump of cavern-hollowed rock suspended in an infinite vacant space. Urged by a vision, a Prince of the Sarâva sets out with two companions in the hope of reaching the surface, and their expedition is successful. With the adventures of the explorers, we have nothing to do, nor is it for us to analyse the sentimental undercurrent. The attractive parts of the story, from the scientific point of view, are those which show the author's acquaintance with electromagnetic waves and the ether. He makes the Sarâva possess machines to etherealise matter, so that by having two powerful electromagnetic foci at any distance apart, it was possible to transmit objects or people from one to the other with the velocity of light; the object being etherealised at one focus, projected to the other, and then by a similar series of electromagnetic waves converted into its material state. Having reached such a high state of knowledge of the ether, it is hardly necessary to say that the Sarâva could see and speak with one another at a distance, without the necessity of connecting wires, and had also managed to tap the ether and use its terrific energies in destructive weapons. How very intelligently, and with what regard to known facts these imaginary machines are constructed, can only be appreciated by a perusal of the book. We congratulate the author on the skilful and original way in which he has handled an old subject.

Frail Children of the Air. Excursions into the World of Butterflies. By Samuel Hubbard Scudder. Pp. 279. Nine plain plates. (Boston and New York: Houghton, Mifflin, and Co. London: Gay and Bird, 1895.)

IT might be supposed from the title of this book, that it was wholly popular, and that entomologists would find little to attract their attention in it; but this would be a great error, for it is really a collection of thirty-one philosophical essays on butterfly and caterpillar life, reprinted, with additions and modifications, from Dr. Scudder's great work on the "Butterflies of New England." Many subjects of great interest and importance are touched upon, relative to the modes of protection of butterflies in all their stages: fossil butterflies; the origin of the present butterfly fauna of North America; the habits of butterflies, caterpillars, &c. One of the most interesting chapters is, perhaps, that relating to the butterfly fauna of the White Mountains of New Hampshire, where butterflies appear to swarm to an extent which the richest localities in Europe could perhaps hardly parallel in number of individuals. Dr. Scudder does not confine his remarks to American species, however, but has also looked up the European literature bearing on his subject very thoroughly, as, indeed, was only to be expected from an entomologist of his industry and energy. Here and there, however, we may detect a casual oversight, as where *Iphiclides podalirius*, L., is spoken of as "confined to the Mediterranean region" (p. 247), when it is really found throughout the greater part of Central Europe as well. Occasionally, too, Dr. Scudder's information can be supplemented, as when in speaking of ants attending the larvæ of *Lycænidæ*, he omits the instances which have been recorded of some Australian species (*Hypochrysops delicia*, Hewitson, and *Ialmenus evagoras*, Donovan, &c., see Anderson and Spry's "Victorian Butterflies," pp. 94, 98, 99). Incidentally various subjects of more general interest are remarked upon, as where Dr. Scudder agrees with Desor (p. 250) in attributing the greater intensity, both of butterfly and of human life in America, as compared to Europe, to the much greater vicissitudes of climate in the former country; or when, in more than one passage, he agrees with Wallace and others, among our deeper-thinking naturalists, that the workings of natural selection are incomprehensible unless we regard them as guided by a controlling intelligence. W. F. K.

The Story of the Earth in Past Ages. By Prof. H. G. Seeley, F.R.S. Pp. 196. (London: George Newnes, Ltd., 1895.)

PROF. SEELEY tells the geological story of the earth in an orderly, though not strikingly luminous, manner. Beginning with evidence of the earth's internal heat, he passes to the materials of mountain chains, and then to the consideration of volcanic rocks. With reference to the latter section, it seems to us that his descriptions of the compositions of rhyolites, trachytes, andesites, and basalts are more suitable for a text-book than for a book intended for popular reading. In fact, Prof. Seeley has too exalted an idea of the knowledge of the general public, who, we are afraid, will not be able to understand a large part of his little book. Few of his unscientific readers will have any idea conveyed to them by remarks such as follow: "The bivalve shells are usually species of *Cyclas*, or *Unio*, or *Anodonta*. The univalve shells are either the pond shells *Planorbis*, *Paludina*, and *Limnæa*, or such river shells as *Neritina*, and the freshwater limpet." Similar instances of the use of technical nomenclature without explanation could be quoted from almost every chapter in the book.

The materials of stratified rocks form the subject of the fourth chapter, and then, after short descriptions of the succession of strata, the origin of stratigraphical geology, and fossils, the formations are treated in order, from the Archæan rocks to glacial deposits and gravel beds. Within the compass of less than two hundred small pages, it has only been possible for Prof. Seeley to indicate a few of the features of the different rocks. Thus, the chapter on Archæan rocks consists of three small pages, and would only fill about a column of NATURE, and there are other chapters just as scanty. Most of the figures are very badly reproduced, and there is no index; so that, altogether, we do not regard the book as a very satisfactory one.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Remarkable Sounds.

IN a book that was popular about fifty years ago, entitled "Journal of a Naturalist," the author says that the purely rural, little noticed, and, indeed, local occurrence, called by the country people "hummings in the air," was annually to be heard in fields near his dwelling. "About the middle of the day, perhaps from twelve o'clock till two, on a few calm sultry days in July, we occasionally hear, when in particular places, the humming of apparently a large swarm of bees. It is generally in some spacious open spot that this murmuring first attracts our attention. As we move onwards the sound becomes fainter, and by degrees is no longer audible." The sound is attributed to insects, although they are invisible.

A writer in the *Edinburgh Philosophical Journal* objects to this sound being attributed to insects, first because the fact is stated as being local and partial, heard only in one or two fields, at particular times of the year when the air is calm and sultry. He has often heard a similar humming in a thick wood, when the air is calm, and has diligently searched for insects, but in no case was able to detect them in numbers sufficient to account for the sound.

The same writer refers to remarkable sounds heard in a range of hills in Cheshire. When the wind is easterly, and nearly calm on the flats, a hollow moaning sound is heard, popularly termed the "soughing of the wind," which Sir Walter Scott, in his glossary to "Guy Mannering," interprets as a hollow blast or whisper. The explanation seems to be that a breeze, not perceptible in the flat country, sweeps from the summit of the hills, and acts the part of a blower on the sinuosities or hollows, which thus respond to the draught of air like enormous organ-pipes, and become for the time wind instruments on a gigantic scale.[1]

The greater intensity of sounds by night is ascribed by Humboldt to the presence of the sun acting on their propagation, by opposing them with currents of air of different density, and partial undulations of the atmosphere, caused by unequally heating different parts of the earth. In these cases, where the air suddenly changes in density, the vibrations which produce the sounds are divided into two waves, and a sort of acoustic mirage is produced in the same manner as a luminous mirage takes place from a similar cause. But there are, probably, other causes connected with the presence or absence, excess or diminution of solar heat, of moisture, &c., which may operate both in the increase or continuance of sound; while many peculiarities of place or season may create or modify certain sounds, which being local, admit only of special explanation.

The distances to which sounds sometimes travel are remarkable. Dr. Clarke, the traveller, states that, while 100 miles from the Egyptian coast, he heard firing therefrom, the air being very still at the time. Dr. Arnott mentions a case in which bells were heard at a similar distance by a ship off the coast of Brazil.

In Madame de Sévigné's gardens at Les Roches, near the town of Vitré, details have been given of an echo of so wonderfully multiplied a character, that rather than describe them, I prefer to ask for further information.

In another book, popular half a century ago, namely, "Forest Scenes," by Major Head, there is a description of sounds emitted by a sheet of ice fifteen or sixteen square miles in area, and three feet thick, when acted on by the wind. "A dreary undulating sound wandered from point to point, perplexing the mind to imagine whence it came, or whither it went, and whether aërial or subterranean, sometimes like low moaning, then swelling into a deep-toned note, as produced by some æolian instrument."

C. TOMLINSON.

Highgate, N.

[1] In the *Annales de Chimie et de Physique* for 1840 is a valuable paper, by M. Fournet, on "Hill and Valley Breezes."

The Story of the "Wandering Jew."

So far as my scanty reading goes, I have never met with a book on the subject of the "Wandering Jew" making mention of an Indian tale in this connection, and I therefore deem it more or less useful to call attention of the folk-lorists to the following Buddhist narrative, for which I have to thank Mr. Seisaku Murayama, an assiduous Pâli scholar in Japan, who was kind enough to make a journey in my behalf with the sole intention of personal examination of the Chinese text. The passage occurs in "Tsah-ö-han-King" (Sa*m*yuktâgama-sûtra, translated by Gu*n*abhadra, *circa* A.D 435–443), printed in Fuh-chau, 1609, tom. xxiii. fol. 30, and may be translated thus:—[This is a portion of an answer of Pin-tau-lu (= Pi*n*dola Bharadvâga ?) to the question of the King As'ôka.] "And further, when the Buddha was staying in the kingdom of S'râvasti with the five hundred arhats, the daughter of the *S*resh*th*in Anâthapi*n*dada happened to live in the kingdom of Fu-lau-na-poh-to-na (= Pundara-varddhana ?), and invited thither the Buddha and the monks. All other monks then, went gliding through the air; but I, exerting my supernatural energy, held up a huge mount and there went. Then the Buddha accused me with these words: 'Wherefore do you play such a miracle? for which offence I now punish you with eternal existence in this world, incapable of the reach to Nirvâ*n*a, thus to guard my doctrine against its destruction.'"

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, W., November 22.

Dr. Baur and the Galapagos.

IN my article on Dr. Baur's botanical collections from the Galapagos (NATURE, vol. lii. p. 623), I stated that he was attached to the U.S. Fish Commission steamer *Albatross*. This was an error. Dr. Baur's trip was quite independent of Government aid, and was accomplished mainly through the liberality of two or three private gentlemen. So far as I can learn, there are no botanical results worth mentioning of the United States Government expedition.

I may add that Dr. Baur informs me that he is planning another visit to the Galapagos group, when he hopes to explore the Revilla Gigedos, Clipperton, Cocos, and Malpelo Islands; but that it cannot be carried out for two or three years to come. The natural history of all these islands is still very imperfectly known. The naturalist of the expedition of H.M.S. *Sulphur* brought home specimens from Cocos Island, about fifty years ago, of a dozen or more flowering plants, indicating no special insular differentiation from common tropical American types.

W. BOTTING HEMSLEY.

A Bright Meteor.

WE have received the following letter through Mr. R. H Scott, F.R.S., Secretary of the Meteorological Council:—

On returning home from sending you my sunshine telegram, this evening (about 7 p.m.) I witnessed the most superb meteor of my lifetime. The best conception I can give of it is to ask you to imagine a gigantic iron bar stretching over, I should say, one-eighth of the whole sky, and glowing as the wire glows in the incandescent lamp. It was almost at the zenith, and came from the east-north-east to the west-south-west. The glow remained for certainly one second, if not more time, and then slowly changed through all the colours of the spectrum, before finally disappearing. I should imagine it was seen over a large extent, and more must be heard of it. I assure you I esteem myself most fortunate to have witnessed a spectacle more magnificent than any before observed by me, although I witnessed the display of November meteors in 1866.

Eastbourne, November 22. R. SHEWARD.

A Long Drought.

IN connection with Brückner's prediction of a dry period culminating at this time, and the letter of Prof. J. P. O'Reilly in NATURE of October 17, the following account of a general drought from a Boston newspaper of November 11, may prove of interest.

H. HELM CLAYTON.

Blue Hill Observatory, November 12.

"The long drought, which has caused so much inconvenience and damage this fall, seems to have prevailed all round the world, if not in every part of it. Europe has experienced it almost equally with this country, and in Australia it has been more severe than here. So great was the distress in New South Wales, that the Government appointed a Sunday in September as a day of prayer for rain, and special services in accord with the proclamation were held in all the churches of every denomination in Sydney and throughout the province. The drought occurred in the Antipodean spring, and greatly retarded planting operations, as well as doing great general damage. In many districts

the grass was literally burnt off the earth, and the mortality among stock was great. The railway trains carried supplies of water from lakes and rivers to all stricken points along the lines, selling it at the rate of twenty-five cents a thousand gallons. The water supply of many towns entirely failed, the inconvenience experienced was acute everywhere, and many agriculturists were ruined.

"All through our own South the drought has been remarkable in its length, and some odd situations have occurred. In Kentucky the beds of many streams that have never before been dry are now full of dust, the mud having become baked hard, and then broken by the wind. At Uniontown, Kentucky, the Ohio was so low that an old coal vein under the river-bed was worked, and thousands of bushels of coal were taken out. In many places along the Ohio, Mississippi, and other streams, old wrecks have been uncovered by the lowering of the water, and the residents along the banks have recovered lots of more or less valuable cargo and junk. At Milton, Kentucky, there is a large sandbar on which many a barge of coal has struck and foundered. This bar was entirely uncovered recently, and the people living near by went to work with ordinary field ploughs and turned up tons of coal. In Maine and other eastern States the drought has been severe. The ice crop promises to be short, because lots of lands have gone almost dry, and there is no water to freeze. These general conditions have existed all over the continent, and in the north-west the situation is as bad as in the east and south."

The Pressure of a Saturated Vapour as an Explicit Function of the Temperature.

IN NATURE (October 24), Mr. Donnan observed that the "Law of Diameters" in combination with any equation of state, such as Van der Waal's, which applies to the region of coexistence of liquid and vapour, supplies an (empirical) expression for the maximum pressure of a vapour at any temperature T in the form of an explicit function of this temperature and known constants.

Led by the same thought, I have found the equation for the vapour tension.

The "Law of Diameters," in combination with the law of Maxwell-Clausius and the equations:

$$\zeta_1 + \zeta_2 + \zeta' = 3\zeta_\kappa$$
$$\zeta_1\zeta_2\zeta' = \frac{p}{ac}$$

{ζ_1 = density of the liquid, ζ_2 = density of vapour, ζ' = density lying between ζ_1 and ζ_2 (labile state)}

gives me

$$p = \mu \frac{(T - T_0)^3\left(\frac{T_\kappa}{T_0} - \frac{T_0}{T_\kappa}\right)}{T^{\frac{3T_\kappa - 4T_0}{T_0}}}$$

{T_0 = temperature, at which the tension of vapour is nil.}
T_κ = critical temperature.

The method of Mr. Donnan gives:

$$p = 3p_\kappa e^{1 - \frac{T}{T_\kappa}} \left\{\frac{24}{27}\frac{T - T_0}{3T_\kappa - 2T_0 - T} - \frac{(T - T_0)^2}{(T_\kappa - T_0)^2}\right\}.$$

If the "Law of Diameters" were consistent with the equation of state, the formulæ would be the same. G. BAKKER.

Schiedam, Holland, October.

Metallic Resistance and Radiation.

A RESULT published by Dr. Aschkinass, to the effect that the electrical resistance of thin metallic sheets like tinfoil is affected by the impact of radiation (electric waves), is often quoted; but, so far as I know, it has not been confirmed. My own experience tends to disprove it; but if any one has succeeded in confirming it, perhaps they would give us the benefit of the information. It is easy, of course, to get spurious effects with bad joints, in accordance with the discovery of Branly; and I see in your "Notes" (p. 60) to-day, that a Japanese experimenter, Mr. Mizuno, is of the same opinion.

November 22. OLIVER J. LODGE.

"L'Arithmétique Amusante."

IN the review of the above book (NATURE, November 7), mention is made of the curious fact that $8 \times 123456789 + 9 = 987654321$. It may be of interest to point out that this is not an isolated numerical curiosity, but is, I find, one of a group of similar curiosities which are included in the following easily proved theorem.

If the number formed by writing down in ascending order beginning with unity the first n digits of any scale whose radix is r be multiplied by $r-2$, and n be added to the product, the result is equal to the number formed by writing down in descending order the last n digits of the scale beginning with the last. WILLIAM LUCAS.

MR. LUCAS's theorem is quite correct: the cases for $r = 10$ have been given by E. Lucas in his "Théorie des Nombres," i. p. 28, as well as (if I remember rightly) in the "Arithmétique Amusante." M. E. Lucas was probably acquainted with the general theorem; whether he published it, or whether it has ever been published, I cannot say. G. B. MATHEWS.

Upper Bangor, November 19.

The Society of Medical Phonographers.

THE address of Dr. Gowers on "the art of writing in relation to medical and scientific work," delivered to the Society of Medical Phonographers, which was mentioned in your issue of August 8, and was published in the *British Medical Journal* for October 7, has been reprinted by the Society. There are a few spare copies, and any scientific worker, who is interested in the subject, can obtain one by sending a penny stamp to Mr. Wm. Holmes, printer, Ulverston.

It may be of interest to state that the number of members of the Society is now 202. I shall be glad to know the name of any scientific worker who uses shorthand.

JAMES NEIL, Hon. Sec.

Warneford Asylum, Oxford, November 22.

THE ROYAL COMMISSION ON SECONDARY EDUCATION.

IT would be difficult to produce a document more typically English than this Report, dated August 13, 1895, of the Royal Commission appointed on March 2, 1894, "to consider what are the best methods of establishing a well-organised system of secondary education in England, taking into account existing deficiencies, and having regard to such local sources of revenue, from endowment or otherwise, as are available, or may be made available, for this purpose, and to make recommendations accordingly."

That our country does not possess even an approach to a system, let alone a *well-organised* system, of secondary education, is in itself a sufficiently remarkable circumstance; but some may think it even more remarkable that, having recognised this, a task so difficult as that before the Royal Commissioners should have been entrusted so recently as last year to persons who, however worthy individually, as a body but very imperfectly represent the vast interests involved in such an enquiry. More than a quarter of a century has now elapsed since the publication of the report of the Schools Enquiry Commission appointed in 1864, and in the interval science has not only advanced with giant strides, but has also been applied to industrial purposes to an extraordinary extent, with the result that a revolution has taken place affecting not only all our actions, but our very modes of thought also, and requiring us to take cognisance of many entirely novel conceptions and considerations. Meanwhile also, our national prosperity has received a most severe check through the competition of those who have been quicker than ourselves to avail themselves of scientific discoveries and methods of working; and the probability is great that such competition will rapidly increase in severity and become unbearable unless we, as Huxley said, "organise victory"—to do which, however, we must march very fast, as we have both to overtake those who are already far ahead of us, as well as go quickly when we come up with them. It was therefore imperative that in considering the organisation of

secondary education, we should fully take into account and avail ourselves of the teachings of science. And it is consequently just cause of complaint that only a single representative of science—Sir Henry Roscoe—should have been placed on the Commission.

NATURE may also well object to the limited construction put by the Commissioners upon the reference submitted to them—that they should have understood it to so confine their enquiries as to lead them to think that it was not their function to include either an examination and description of the instruction now actually given in secondary schools, or a consideration of what subjects it ought to cover, and by what methods it should be given; and that consequently they should have mainly restricted themselves to what they call the external or administrative part of the subject. This, to the ordinary mind, is not unlike leaving out of account the weapons used in modern warfare, as well as all questions of tactics, in considering the organisation of our defensive and offensive forces; as education must in the future be the arsenal in which our weapons both of defence and offence will be mainly fashioned, the parallel can scarcely be said to be wanting in appositeness. It is all the more remarkable that the Commissioners should have taken so narrow a view, as on the second page of the Report they say that the object they had before them was nothing less than to complete the educational system of England, now confessedly defective in that part which lies between the elementary schools and the Universities.

Among those who have studied the conditions of English education and compared it with the best foreign systems, who are aware of the state of English public feeling on such matters, and who also take into account the altered conditions under which we now live and work, the impression is strong, however, that nothing is more wanted here than a clear declaration of policy which would serve to form public opinion and lead it into the right direction as regards the character of education most suited to the times. Although confessedly a practical people, we continue to allow our children to receive an education bearing little relation to the practical needs of life; the reason being, probably, that we do not sufficiently recognise that we owe our success almost entirely to innate good qualities, and that Englishmen have been helped in a comparatively small degree in what they have done by their school training.

It should have been easily within the powers of the Commissioners to have properly discussed such questions, and it is surprising that it should have been found difficult "to secure the help of those who, while not directly or professionally connected with secondary schools, had studied educational problems." And besides hearing witnesses belonging to the class of "educational statesmen and thinkers," workers might perhaps have been listened to with even greater advantage—when the theoretical evidence tendered by some is contrasted with that of an accomplished and experienced worker like Miss Beale, for example, there is no difficulty in deciding which is the more valuable. If also the opinions of a few experienced instructors at the universities and elsewhere, who have to do with large numbers of average students from secondary schools, had been invited, material would have been accumulated of importance in determining our future educational policy, and which probably would have led the Commissioners to open their eyes very widely: information as to the previous places of education of undergraduates at the universities is of little use in comparison with information as to the quality of their attainments.

Not a single scientific witness was called! Yet, if among the memoranda on particular topics invited from persons believed capable of furnishing valuable data or views, memoranda on the place of science in education and the kind of teaching required had been invited, there would not only have been no difficulty in securing such, but the documents would have had a high value. The mere fact that technical education was included in the enquiry, and indeed occupied a very considerable share of attention, is in itself sufficient evidence of the necessity of taking such a subject into consideration. But the Commission was clearly so constituted that it could not appreciate the importance of such action being taken, composed as it was very largely of men who cannot be regarded as belonging to the modern school of educational thought. Consequently, and most unfortunately, it has contributed little, if anything, towards the understanding of the difference between true scientific teaching—not merely of science, but of all subjects—and the sham article with which this country has so long been flooded; the wearying fight to bring this home to all concerned must therefore be continued with unremitting vigour. And this is the more disappointing, as it is so clear that, had the Commissioners advanced but very little further, they could have helped us in this direction also; for how otherwise are we to interpret the following admirable conclusion to the summary appended to the second section of the Report, that relating to the present condition of secondary education in England?—"In every phase of secondary teaching, the first aim should be to educate the mind, and not merely to convey information. It is a fundamental fault, which pervades many parts of the teaching now given in England, that the subject (literary, scientific, or technical) is too often taught in such a manner that it has little or no educational value. The largest of the problems which concern the future of secondary education is how to secure, as far as possible, that in all schools and in every branch of study the pupils shall be not only instructed, but educated. The degree in which this object may be attained will be largely influenced by the action of the authorities who prescribe the qualifications to be required in teachers, the conditions under which their work is to be done, and the means by which their work is to be tested."

Surely it was the duty of the Commissioners to take the first step towards solving what is admitted by themselves to be the largest of the problems concerning the future of secondary education—it is not likely that another Commission will be appointed to do this!

The Franco-German War first drew the attention of the world to the extraordinary value of exact training and scientific organisation. The lesson was most taken to heart by the Germans themselves, and by carefully training the *officers* of their army of industrial workers, they have since come off victorious in many important engagements with rival manufacturers and traders. An almost deeper lesson has recently been given to the world by the Japanese. Unless *we* are prepared to entirely disregard such lessons, we must introduce drastic reforms into our whole system of education. Scientific ways of working—scientific habits of thought, must be made national habits. The change would be nothing like so absolute as that made by the Japanese in their system of working, and if such a nation could entirely alter its front, it should not be beyond our power to do what is so clearly essential to our continued existence in comfort, let alone prosperity.[1]

[1] I cannot refrain from quoting the following conclusion to a striking article on the "Far Eastern Question" in to-day's *Times* (November 27). "Although nothing can excuse the short-sighted folly of our manufacturing classes in not providing for scientific research in the various branches of industry, yet it is the duty of a wise Government to take measures to counteract the folly of classes when it threatens the general interest. In one word, Great Britain stands at this moment in imminent danger of being beaten out of the most lucrative fields of commerce, simply because it does not recognise, while other nations do, the value of scientific organisation in the field, in the workshop, in the laboratory, and in the conduct of national policy." The *Daily Telegraph* has recently published an interesting series of letters—"Lessons in German"—conveying a similar lesson. We have waited long for the daily press to assist us: such evidence that the gravity of the situation is at last attracting attention is therefore most valuable.

To have conveyed this lesson to the nation should have been the first duty of the Commission. It is difficult to discover a sentence in the Report which indicates that they appreciate the gravity of the situation in which we are placed! Englishmen require but to be led properly at starting—when once they understand what to do, they will help themselves. The extraordinary outburst of educational activity which the country has witnessed during the past twenty years is proof that we are not behind in our estimation of the value of training; but the amateur fashion in which a very large proportion of our new enterprises have been conducted, shows only too clearly that an ideal is wanted to guide our labours: if we had this, co-ordination of means would naturally follow. We realise, in fact, that our army must be drilled, but we want a new national drill-book, in which the tactics to be adopted are *broadly* indicated. The Commissioners have only advised us as to the construction of barracks, and the choice of a staff; still, if we follow their advice and not only choose our staff, the Minister and his Educational Council, wisely, but impose on the latter in the first instance the task of most carefully framing the outlines of a system of tactics, all may yet be well.

Whatever may be the shortcomings of the Report in these respects, all who study it must agree that it is a work of the very highest value, drawn up with great skill, and that the recommendations embodied in it merit the most serious consideration.

In addition to the Report, there are three volumes of minutes of the evidence tendered by eighty-five witnesses; a fifth volume contains memoranda and answers to Commissioners' questions; two others are devoted to the reports of Assistant Commissioners; and the remaining two contain a summary, an index and statistical tables.

As the Commissioners point out, a mastery of the details is essential to a comprehension of the problems they had to solve, and an appraisement of the solutions they offer. Perhaps those who can read between the lines may be inclined to draw inferences in some cases different from those arrived at by the Commission; and it is clear, also, that the evidence is not all equally trustworthy—at least one of the Assistant Commissioners' reports having called forth what appear to be just protests.

The opening section of the Report contains a very brief, but most instructive, historical sketch of the gradual development since 1867 of the various agencies which have induced progress; four are chiefly referred to: the Elementary Education Act of 1870, the Science and Art Department, the various new University Colleges and the women's colleges, and the Technical Instruction Act; the work accomplished by voluntary effort, and the great increase in public interest in educational matters being also specially mentioned. Most hopeful in tone, this section is sadly wanting in scale; while no distinction is made between the work done under the Science and Art Department and by the University Colleges, the reference to University Extension is of the roseate order usually made by its extreme advocates. It is unfortunate that no attempt to estimate the relative values of the different elements of our educational "system" is included in this or the following section.

The second section deals with the present condition of secondary education in England, under the three heads: authorities exercising control, the existing supply of secondary teaching, and bodies which examine or inspect. The problems which the survey suggests are then considered, and, among others, the defects are pointed out in the present system of science and art grants, in the supply of schools, and in the provision of scholarships; but, unfortunately, under this last heading no attempt is made to take fully into account the bad, as well as the good, effect on scholars and schools of scholarships: the subversive effect they have produced at our universities is so generally recognised by competent observers that this subject should have been carefully considered. In discussing the internal organisation of schools in this section, stress is laid on the need of training for secondary teachers. This, perhaps more than any other portion of the Report, requires most careful study in connection with the evidence, and remarks on it must be reserved for a future occasion. The measures to be taken in the training of teachers will undoubtedly be the most vital point in any future legislative action arising out of this Report; for given good teachers, good work will necessarily be done, whatever the conditions may be in other respects.

A most important paragraph occurs in the summary to this section, which will need to be very carefully discussed, viz. that "In organising the supply of schools, it will be of the utmost importance to provide adequately for the literary type of secondary education, no less than for the scientific and the technical." One question to be considered is whether there should not be a *mean* type instead of distinct types throughout all the earlier stages, at least, of secondary education. Unfortunately this issue seems never to have been presented to the Commission.

The third section, which is by far the longest, is devoted to a review of the evidence, and a discussion of the suggestions made by certain witnesses.

The fourth, and practically the most important, contains the recommendations which are unanimously brought forward by the Commissioners. The primary recommendation, to which probably most interest attaches, is that of a *Central Authority* calculated to bring the State into a fitting relation to secondary education—words deserving of special notice. The proposal made is essentially English in spirit, and thoroughly calculated to fall in with our belief in a decentralised system of local self-government giving the maximum opportunity to individuals. "So far from desiring that secondary education should be a matter for a department of State to control," say the Commissioners, "we propose to leave the initiative in public action to local authorities, and to prevent even those authorities from superseding the action of individuals. So far from attempting to induce uniformity, we trust that a free and spontaneous variety, and an open field for experiment and enterprise of all kinds, will be scrupulously observed. We conceive, in short, that some central authority is required, not in order to control, but rather to supervise the secondary education of the country, not to override or supersede local action, but to endeavour to bring about among the various agencies which provide that education a harmony and co-operation which are now wanting."

The Central Authority proposed is a Minister responsible to Parliament presiding over a department formed by merging into one body the present Education Department, the Science and Art Department, and the Charity Commissioners. Apart from other advantages, the appointment of a Minister of Education must have the effect of impressing on public attention the immense national importance of educational affairs; and much as we have been indebted in the past to the several departments which it is suggested should now be fused into one, their methods are too inelastic to suit modern needs, and the proposed change is probably one which will meet with the approval of all true friends of education.

It is further proposed to associate with the central authority an Educational Council, not exceeding twelve members, of whom one-third might be appointed by the Crown; one-third by the four universities of Oxford, Cambridge, London, and Victoria; whilst the remaining one-third might be co-opted from among experienced members of the teaching profession. This proposal will probably be viewed in very different ways, but it appears to be one which is eminently calculated to pre-

serve the educational freshness of the central authority, and limit within reasonable bounds the display by it of those peculiarities which are too frequently manifest in all official bodies; through such a body, the interest of the Minister, and through him of the country at large, in current educational problems would be awakened and maintained, and he would become fully open to influence from without; at the same time, it should minimise the tendency to subordinate educational to political interests. But to secure these ends, the Council must contain a large professional element, and its members must not in any case be mere men of affairs, but fully acquainted with educational requirements.

It is impossible now to discuss the remaining recommendations.

At the outset, the Commissioners state that they have felt very strongly the need of dispatch, in order that the country may without delay derive advantage from legislation framed on proper lines. It is to be supposed that the late Government would have acted promptly in the matter, and it is to be hoped that its successors will be at once ready to appreciate the vast importance to our nation of well-considered legislation in the direction of the scheme put forward by the Commissioners. It would probably be difficult to prepare one in which due provision is more fully made to conserve what is good in our present system, while permitting the fullest play to the agencies which determine progress.

To conclude, in the eloquent final words of the Report, "it is not merely in the interest of the material prosperity and intellectual activity of the nation, but no less in that of its happiness and its moral strength, that the extension and reorganisation of secondary education seem entitled to a place among the first subjects with which social legislation ought to deal."

HENRY E. ARMSTRONG.

PAGAN IRELAND.[1]

TO Colonel Wood-Martin is due the credit of the first attempt to co-ordinate the vast stores of archæological lore which lie buried in the publications of the various Irish societies. The subject is a really fine one, and it was time that the data of Irish archæology should be collated and presented in a convenient form. This the author has accomplished. There are two ways of regarding a book: the one is to expect the author to write the book in the way you (whoever "you" may happen to be) would like to have it written, and the other is the acceptance of the author's position, and to deal with the work from that point of view. It is not difficult to discover the ideals which the author has in this instance placed before himself. "In order to arrive at the truth, it is desirable to test the opinions and conclusions of those who, by a careful analysis of the probabilities and facts recorded by them, have travelled over the same ground before. . . . Antiquarian research in Ireland may, with advantage, be directed towards filling in the social history of primitive man; articles which are the result of the handiwork of the aborigines illustrate, with much exactitude, life in the olden days. . . . If material objects be accepted as proofs of the pagan ideas and customs of the aborigines, surely the evidence of still existent superstitious observances of the peasantry, which can be traced to a pre-Christian source, ought to be received with, at least, the same authority. . . . It is to be hoped that research into the past, on these lines, may contribute to the reconstruction of early history." This is a sound method of treating archæology; our author clearly recognises that the value of archæology, whether it be of objects made by man, or of folk-lore, lies in the use to which it can be put in deciphering the early history of man, and he admits that in Ireland "we have made but little progress in higher scientific archæology; and the ancient antiquities of Ireland still remain in an unclassified condition." This is a refreshing admission, and the justification of this statement is only too apparent to those who know the present unintelligent arrangement of the magnificent collections of the Royal Irish Academy, now housed in the Dublin Science and Art Museum. The splendid opportunities for archæological research which exist in Ireland, are woefully neglected, and it is to be hoped that Colonel Wood-Martin's book will serve to stimulate an interest in this fascinating and promising field of inquiry. We are glad to note that he refers to the "vandalism" of the Board of Works with regard to ancient monuments; but a great deal more has yet to be said on this subject.

FIG. 1.—Legananny Cromleac, Castlewellan, Co. Down, 10 feet in height. (From Welch's Irish views.)

In his chapters on "Early History," "The Disposal of the Dead—Were the Aborigines Cannibals?" and "Traces of the Elder Faiths," the author deals with customs and beliefs as recorded in ancient accounts, or as witnessed for by actual remains, or as perpetuated in an attenuated form in folk-custom. The facts here collected together are most interesting, and throw considerable light on the early social condition of Ireland, a good deal of which will be new to the ordinary reader.

The author is very weak in his account of the ethnology of ancient Ireland; but this is a matter in which the author, not being a professed anthropologist, is not so much to blame, and there is yet much investigation to be done before we can speak with certitude. At

[1] "Pagan Ireland, an Archæological Sketch. A Handbook of Irish Pre-Christian Antiquities." By W. G. Wood-Martin, M.R.I.A., author of "The Lake Dwellings of Ireland," "The Rude Stone Monuments of Ireland," &c. 689 pp., 410 figs., and map. (London: Longmans, Green, and Co., 1895.)

all events it is a pity to promulgate the statement that "the Esquimaux and cognate people appear to be all members of the most primitive family amongst

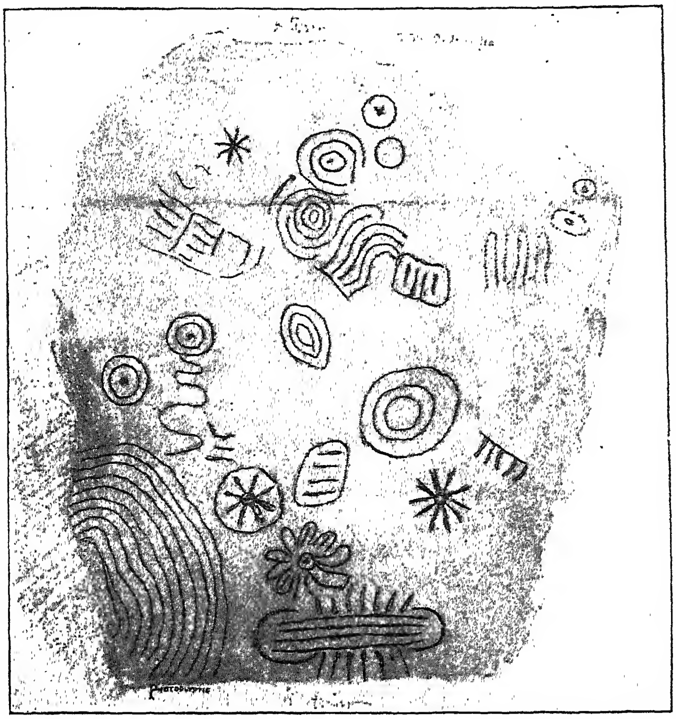


FIG. 2.—Inscribed Stone from a Carn on the Loughcrew Hills, Co. Meath.

the nations," and he adopts the view that the men of the period of the megaceros and the reindeer "approximated in type to that now inhabiting the Arctic regions." He is apparently unaware of the distinguishing cranial characters of the Lapps and Eskimo. While admitting that there is a culture analogy between the latter people and those of Neolithic times in the British Islands, there is no evidence for ascribing them to the same race. The figures of the skulls on p. 21 are ludicrously erroneous.

When Colonel Wood-Martin passes to the more well-beaten paths of archæology, there is less to criticise, and it is evident that he writes not only of facts gathered from a large range of reading, but also from wide personal knowledge. We have a satisfactory epitome of what is known on early domestic architecture in the shape of beehive huts, souterrains, cashels or forts, raths, and the like; as the author has made a special study of crannogs, the Irish lake-dwellings are adequately described. There is an interesting chapter containing a good deal of folklore on various rude stone monuments, including cromleacs, carns or tumuli, pillar-stones, holed-stones, &c. Clay vessels and stone urns have a chapter to themselves, and a number of them are figured. In dealing with stone implements we find this statement: "In the Palæolithic or ancient stone period, the manufacture of implements was so rude that it is difficult to distinguish between the flints artificially chipped by human agency, and those shaped by natural causes." As it stands this is very misleading, for the ordinary Palæolithic implement is as recognisable as the Neolithic.

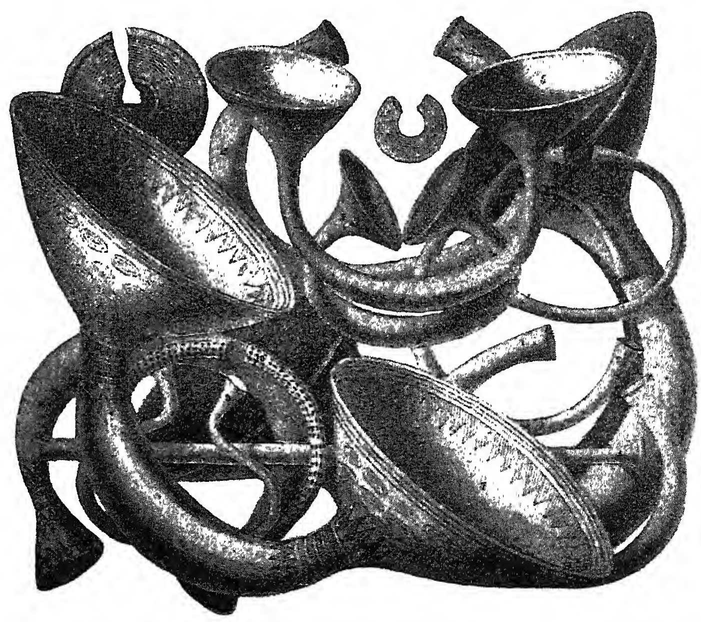


FIG. 3.—Group of miscellaneous Gold Ornaments (total value, £1000). Slightly less than one-half natural size.

A succinct account is given of the various kinds of stone arrow-heads, and of the bronze swords, daggers and spear-heads, and they are classified according to their several types; but we are not given any information as to their distribution, nor is any clue given as to their relative dates of the bronze weapons or of their foreign equivalents. The well-known story of the evolution of the socketed hatchet from the simple flat copper celt is, however, detailed. The famous gold ornaments are duly described, and from the number of ornaments in museums, especially in the Museum of the Royal Irish Academy, and from the records of finds, there is abundant evidence that Ireland was at one time very rich in that precious metal; indeed, it is probable that gold ornaments were an important article of trade, and we know that the Danes and other Scandinavians raided the country and rifled the tumuli and other tombs, being tempted by these valuables. During the present century, between £30,000 and £40,000 worth of gold ornaments are known to have been melted down.

A number of the mysterious rock-scribings are illustrated, but no fresh light is thrown upon them; indeed, the chapter on ornamentation is not so satisfactory as it might have been.

The book is well printed, copiously illustrated, carefully indexed, and one very valuable feature is the bibliography, which gives a classified list of over a thousand references.

To sum up: the author has aimed high, and has evidently spared no pains to do his best, and he has succeeded in producing a book which affords an extremely convenient introduction to Irish archæology; he has compiled diligently, but the exercise of more criticism, and of a broader way of regarding the data of archæology, would have resulted in a better book; despite his own ideals the author has not succeeded in getting, so to speak, outside his subject.

THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

A DEPUTATION representing forty-six Chambers of Commerce, announced in these columns a fortnight ago, waited upon Mr. Balfour, First Lord of the Treasury, on November 20, to urge upon the Government the desirability of adopting the metric system of weights and measures, as recommended by the late Select Committee on the subject. It will be gratifying to men of science to know that the commercial world has been brought to support a reform advocated by them for many years. When the question was merely one of simplicity, little importance was attached to it, but now that commercial men have learned that our chaotic system of weights and measures is a serious obstacle to international trade, the matter is taken into the region of practical politics. On the whole, Mr. Balfour's reply to the deputation is satisfactory. The best way to the adoption of the metric system in this country is by educating the mass of the people in its use; in other words, the transition will have to be gradual rather than an abrupt change brought about by legal process. By all means let the metric system be legalised, but it cannot be seriously believed that in two years people would submit to having the system thrust upon them by Act of Parliament. The Select Committee of the House of Commons recommended "That the metrical system of weights and measures be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than it is at present." This recommendation ought certainly to be carried out, for when the use of decimals has become common, and the convenience of the metric units has become widely known, there will be little need for legislation to make the use of the system compulsory. But the question is not only one of ways and means; for if England adopts the metric system, then France will, in all probability, adopt Greenwich time, and there will then be one time system throughout the world.

The deputation to Mr. Balfour was introduced by Sir A. K. Rollit, M.P., who was supported in his remarks by Sir Henry Roscoe, Sir Samuel Montague, M.P., Mr. Arnold-Forster, M.P., and several other members.

Sir Henry Roscoe said: As Chairman of the Select Committee, the report of which has been referred to in the memorial, I desire, Mr. Balfour, to be allowed to say a few words on the question at issue, of which, I may add, it is difficult to overestimate the importance; and, in the first place, I wish to remark that the Committee consisted of seventeen Members of Parliament, chosen from both sides of the House, and that of these seventeen only one was opposed to the recommendations made by the majority and embodied in the report—*i.e.* that the metrical system of weights and measures should be at once rendered legal for all purposes of trade as well as for manufacture; and that, further, within a space of two years, the metrical be adopted as the only legalised system. These recommendations were founded on the evidence given by thirty-two witnesses, representing very many different interests, and selected from persons of every class of the community. Of these only one—*i.e.* Sir Frederick Bramwell—was in favour of retaining the present system, although he had no objection to the legalisation of the metrical weights and measures. With this single exception all the witnesses expressed a very strong opinion as to the evil effects arising from the complicated and unsatisfactory condition of our present system of weights and measures. They called attention to the distinct and serious degree to which, in their opinion, our commerce—especially our foreign commerce—is handicapped in consequence of the use of the present system, differing, as it does, from that now adopted by every European nation except ourselves and Russia, as well as by far the greater majority of the non-European countries with which this kingdom trades. Not only, however, was it proved to the satisfaction of the Committee that our foreign trade suffers greatly, but also that our home trade would be benefited by the adoption of a simpler and uniform system of weights and measures.

From the educational side, also, evidence showed the urgent need of an adoption of a simpler system, and it appears from the statements of experts that the school time now devoted to arithmetic would be lessened by one year if a simpler system were substituted for the cumbrous one now in vogue, and thus our children placed on a par with those taught in foreign schools. This led to the second recommendation—viz. "That the metrical system be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than is the case at present, and before vulgar fractions."

On inquiry, the Committee learnt that the compulsory changes from old and complicated to a new and simple system had been accomplished in Germany, in Norway and Sweden, in Switzerland, in Italy, in Bulgaria, in Japan, in Turkey, and even amongst the black population of French dependencies in Africa, without any difficulty in a comparatively short period of time, and without any opposition; that in every case the people in these countries are satisfied that the change has been for the better, and that in no single instance has an attempt been made to recur to the old system.

It has often been stated that this agitation for the adoption of the metrical system is got up by scientific men or faddists, who have no knowledge of the practical difficulties which will arise in the application of a new system to ordinary life. That this is not so is shown not only by the composition of the present deputation representing, as it does, so powerfully the commercial interests of the Empire, but also by the statement emphasised in the evidence given before the Committee, that the working classes, at any rate the more intelligent of them, are interesting themselves in the matter and have passed very strong resolutions in favour of the change. Thus the Trade Union Congress held in Glasgow in September 1892, at which 495 delegates were present, representing nearly a million and a quarter of members, passed the following resolution: "That in the opinion of this congress it is highly desirable in the interests of the working classes and of the general trade of the country that the decimal system (meaning the metrical system) of weights and measures shall be adopted in Great Britain and Ireland as a national system, and that a Parliamentary Committee be instructed to promote legislation on the question"; whilst a similar resolution was passed at the Belfast Congress in the following year, at which 380 delegates were present representing 900,000 members. A large number of other trade societies have sent in memorials in favour of the adoption of the metrical system; amongst many others, the United Bargemen and Watermen's Protection Society, the Working Men's Club and Institute Union, the Trades Councils of Sheffield, Glasgow and Bolton, the National Union of Gas-workers, the Boot and Shoe Union of Leicester, the Manchester and Salford Trades Council, the Dockers Union, the Amalgamated Society of Railway Servants in Scotland, and the General Railway Workers Union.

Important evidence was obtained from manufacturers who have adopted the metrical system in their works; the most interesting of these is perhaps that of Captain Sankey, a director of the well-known firm of Willans and Robinson, engineers. This firm has adopted the metrical measurements, not only to their own advantage, but to the satisfaction and with the cordial co-operation of their workmen, some of whom are merely ordinary English labourers. A series of questions was drawn up by the firm, for the purpose of ascertaining how far the men were satisfied or otherwise with the change, and the answers to a number of searching questions showed that the men were not only satisfied but pleased, and had no wish to recur to the old measurements. An honourable member of the Committee asked this witness whether he had found that his men had any difficulty in adapting themselves almost immediately to the new system, and the answer was, "Not after the first few days." The witness added: "I asked that very question to the head of our tool-room, and he said it was a little awkward for a time. I said, 'About how long?' and he said 'Two days.'" And in further examination this witness stated that the workmen knew nothing of the metrical system beforehand.

Another interesting witness was the Chairman of the Incorporated Society of Inspectors of Weights and Measures. He came forward as an expert in these matters, and he agreed that the metrical system ought to be made compulsory, and in expressing this opinion he spoke for his Society. He gave a long list of anomalous customary measures, which are now, although illegal, still in use

in various parts of the country. He explained that it was difficult, under the present system, to prevent the use of these irregular weights, but that if a new unit or system were adopted, then it would be possible to put an end to the employment of these ridiculous so-called customary weights.

The Committee found it impossible to obtain any evidence either from manufacturers, from retail dealers, or, with the exception I have mentioned, from professional men, in opposition to the recommendations which they have made; and amongst the members of the Committee the one opponent of their recommendations was Mr. Stevenson, who added a report of his own, which is printed with the evidence, but which did not find a seconder. Reference was made to the fact that, in the Parliamentary Report of a Committee which sat thirty-three years ago on this subject, two very distinguished men of science—*i.e.* the late Astronomer Royal, Sir George Airy, and Sir John Herschel—expressed strong opinions in opposition to the adoption of the metrical system. One witness, Lord Kelvin, on being asked by the Chairman how far in his opinion that evidence applies at the present time, answered: "I believe these two great men would see things very differently now; their minds had not been opened to the great advantages of the metrical system. Since they gave that evidence every country in Europe has accepted the metrical system except ourselves, and the general understanding of these subjects has certainly advanced very much"; and he went on to say that he did not think that at the present moment a Committee on the subject need consider the objections thus raised thirty years ago as being of importance; on the contrary, he would like to see the metrical system made compulsory after the lapse of a certain period, and would not be satisfied without a thorough adoption of this as the only legal system in the country. Moreover, he did not think decimalisation of the coinage was at all a necessary accompaniment for the adoption of the metrical system of weights and measures.

Further evidence went to show that in the United States the metrical system was actually legal, was in use within the State of Utah, and has been adopted as a compulsory system for all pharmaceutical and medical purposes; that this latter also is the case in Russia; and quite recently the announcement has been made that in the new edition of the "British Pharmacopœia," about to be issued, the metrical weights and measures will be adopted. It appeared to be a general opinion amongst witnesses consulted by the Committee that it only requires that England should take the initiative, in order that both Russia and the United States—the only civilised countries now not using the system—should at once adopt it, and thus all nations would have one and the same system, and that this would be an incalculable benefit to mankind.

Mr. Balfour is reported by the *Times* to have replied as follows: "I have listened with very great interest to the powerful speeches that have been made upon the important subject with regard to which we are met here to-day. If I may express my own opinion upon the merits of the case, there can be no doubt I think whatever that the judgment of the whole civilised world, not excluding the countries which still adhere to the antiquated systems under which we suffer, has long decided that the metric system is the only rational system. Scientific men in this country have long been driven to use it in their writings, to use it in their calculations, and, if I may so express it, to think in it, to think out the problems in which they deal in the system which we owe to the ingenuity of the French. What men of science have long been obliged to do—not merely because the international character of science makes it desirable, but also because the calculations are so much more rapid, so much more convenient—what men of science for those reasons are obliged to do, I believe that commercial firms in all parts of the country are beginning to think they must do also. On that point I do not think that argument is possible. The solitary argument which appears to have been alleged on the other side is that the existing English system is a good gymnastic for the mind. I dare say it would be a very good gymnastic for the body if, instead of having macadamised roads, we were obliged to make our way over pathless heaths and plunge through ditches and over hedges; but though it would be an excellent gymnastic for the body it would not be a convenient method of getting from place to place, and I do not think any one is likely to recommend that we should return to the primitive kinds of locomotion once used by our forefathers. There appears, therefore, to be an absolute agreement on the merits of the case. There is no such agreement with regard to the practicability or the ease of carrying out any great change. We in this country are rather in the condition of an industrial concern which was using antiquated plant, but which felt that it could not renew that plant according to modern requirements without an immense expenditure of capital which for some years would destroy all the profits, or a large part of the profits, of the undertaking. In precisely the same way, while everybody admits that the change when once effected would be a change of almost universal beneficence, I think we ought not to conceal from ourselves that there would be loss and inconvenience during the period of transition. I think we have only got to consider our own personal experience to see that that is so. Like the rest of the world, I have had to read books in which the metric system was the one in use. As I have been brought up on the English system, there has always been a certain difficulty in representing to the imagination without effort and immediately by an automatic process exactly what was intended. To translate miles into kilometres is not a very difficult process, but it is not automatic even to the person who knows the exact length of the kilometre and mile. And what is difficult to us who have been to a certain extent habituated to both systems, would certainly be difficult to the great mass of retail traders and the great body of the poor. They have been accustomed to think in one kind of measure, and to require them by law suddenly to think in another kind is to compel them to go through an effort which I think every one will admit would be an arduous effort in some cases, and an effort which would not be unaccompanied by mistakes and difficulties on the part of those who are unaccustomed to it. It is a matter, it will be observed, largely of familiarity and imagination. We all know what we mean by a yard. To translate that into a metre requires a little effort. We all know what we mean by a mile, to represent it in the imagination, but to translate it into a kilometre requires an effort, and I do not think we should underrate the obstacles in carrying out the beneficent change. I was struck by what fell from Sir Henry Roscoe and some other members of the deputation with regard to the extraordinary vitality in England of antiquated and illegal weights and measures in different parts of the country. Although our existing measures are the only legal ones, it appears that other measures are in habitual use by large portions of the population. If old measures are so difficult to kill, as they clearly are, we must not forget that we have a very heavy task before us to bring about the great change of the existing system to the decimal system. I have been informed that in France, where the metric system has now long been in use, where it is universally believed in as the only rational system, I believe that even in France, in some parts, the population prefer some of the old measures which their fathers were accustomed to rather than the rational system which has now for more than two generations been the only legal one in force. Therefore we ought not to approach the solution of this problem in too sanguine a spirit. I observe that there are three recommendations which the Chambers of Commerce have formulated and embodied in the memorial presented to me to-day. The first is that the metrical system of weights and measures should at once be legalised for all purposes. The second is that it should be the only legal system allowed in this country after two years. The third is that every effort should be made to teach it in the elementary schools. With the first and third of these I find myself in entire agreement. I am told that there are legal obstacles to the use in all trades, and I am quite unable to see why that obstacle should be continued. I think it is our business to do everything we can to smooth the transition from the old to the new system, and certainly the first step towards smoothing that transition would be to make legal that which we think desirable and which we may ultimately think necessary. I was struck by an observation from Mr. Arnold-Forster in regard to the standing orders of the House of Commons, and to the exclusion of the metric system from our national manufactures—that is, manufactures undertaken by the Government. I think both of those are topics well worthy of consideration, and I shall consult with my friend Mr. Ritchie and the other departments of the Government concerned to see whether from either of those points of view anything can be done to meet the general wishes of the commercial classes as represented by the Chambers of Commerce. With regard to the teaching of the metric system in elementary schools, I believe something has been done already in that direction by the Education Department, but on that topic also I shall consult

Sir John Gorst and see whether we cannot do something to spur on the teaching of the metric system in the schools, and thereby familiarising the imagination of the rising generation to a system which perhaps ultimately will be the only one they will be permitted to use. With regard, however, to the second proposition in the order of statement by the Chambers of Commerce, you will have gathered from what I have said that I should see very great difficulties in compelling every class in the community suddenly to alter its familiar and habitual practice in regard to the weights and measures in which it deals. If I may venture to say so, I hardly think that the Chambers of Commerce, or even the trade union congresses, are adequate representatives of the kind of feeling which would probably animate the great mass of small retail dealers and those who buy their goods from such dealers, who would suddenly find all their familiar landmarks swept away and unfamiliar things put in their places. You represent the great commercial interests of the country, and possibly you might find a degree of opposition to your proposals which you little anticipated if you were to endeavour to drive into every cranny of our social system changes which no doubt would be very beneficial as applied to the great industries and manufactures. That leads me to ask—if the advantages of the metric system as compared with the existing system be so great as you tell me they are, as I fully believe they are—whether they could not now be adopted, for instance, in shipbuilding yards on the Clyde, in the great machine-making industries of Manchester, and in such commercial centres as Belfast. I think one gentleman did mention a firm which had employed it, and which had no difficulty in employing it. The engineers do it now, and they have not found much difficulty in doing it, and they have derived much benefit from it. Surely it is within the province of private enterprise to extend that system to every one of the great industries which bring us into relation with foreign countries. The foreign meat trade is already largely carried on on a decimal system, but not the metric. What I want to insist upon is that, while it is of great importance to render such a change easy, it is within the province of private enterprise to carry it out gradually in those great industries. I cannot but believe that if you represent, as I am sure you do, the feeling of the great industries in this matter, we shall find, without any compulsion on the part of the Government at all, the metric system making its way through all the leading industries. It must be legalised certainly, but, when legalised, it will make its way. It is evident that, in so far as that process is carried on, you would enormously facilitate that ultimate compulsory change to which we all look forward, but which, I think, could not, with safety or advantage, be undertaken by the Government till public opinion is more prepared for it than at present. The public opinion with which we have got to deal, and which we are bound to consider, is not the public opinion of the great manufacturers alone, but the public opinion of every man and woman you meet in the street. While I look forward to the time, and no distant time, when they will adopt the change without difficulty and without repugnance, I should like to see private enterprise do more than it has done up to the present to show that the change can be adopted without inconvenience, and that it carries with it all the benefits which I, in common with you, firmly believe to be attached to the metric system, and which it is impossible to associate with the arbitrary, perverse, and utterly irrational system under which we have all had the misfortune to grow up."

NOTES.

A LARGE and influential deputation is to wait on the Duke of Devonshire at noon to-day to urge on the Government the importance of introducing, at an early date, a Bill appointing a Statutory Commission to give effect to the recommendations of the late Royal Commission on the London University question.

THE first meeting of the General Committee of the Huxley Memorial was held, under the presidency of the Duke of Devonshire, yesterday, as we went to press. The chief object of the meeting was to decide the form which the memorial should take. The long list of the General Committee, consisting of the names of men of light and leading in all parts of the world, is a striking testimony to Huxley's greatness.

THE Egyptian Government have determined to commence a geological survey of the "land of Egypt." The work will be begun next year, and will take about three years for its completion, the estimated cost being £25,000. To carry out the proposed plans, a wise selection of a geologist has been made in the person of Captain H. G. Lyons, R.E., who is at present engaged (under the Public Works Department of the Egyptian Government) in superintending the excavation of the ruined temples of Philæ. Captain Lyons has already written an excellent article on the "Stratigraphy and Physiography of the Libyan Desert of Egypt" in the Geological Society's *Journal* for 1894, and has also made extensive explorations on the Upper Nile. Had the Egyptian Government taken this step some years ago, they might have saved some considerable sums of money which they have squandered in searches for petroleum and various minerals, undertaken at the instigation of inexperienced and interested advisers.

A SHARP earthquake shock occurred at Athens at 7.30 on Wednesday morning, and was also felt at Chalcis, Livadia, Thebes, and Corinth.

DR. J. D. GILCHRIST has been appointed Marine Biologist to the Government of the Cape of Good Hope. He will be charged with the investigation of the marine resources of the country, especially in their practical relations to the fisheries.

A COMMITTEE has been formed to make arrangements for presenting to Prof. Adolf Bastian, Professor of Ethnology in Berlin, a volume of original essays on various branches of ethnology, anthropology, and kindred sciences, when he attains his seventieth birthday in June next.

WE learn from the *Lancet*, that the Health Committee of the Glasgow Town Council has decided to establish and equip a complete bacteriological department in the sanitary buildings now in course of erection. The laboratory is to be in charge of an expert in bacteriology.

THE *British Medical Journal* states that Prof. Loeffler, of Greifswald, the discoverer of the diphtheria bacillus, has received from the French Government the Officer's Cross of the Legion of Honour.

DR. CARTWRIGHT WOOD has been granted £100 out of the Goldsmiths' Company's grant allocated by the Committee of the Conjoint Laboratories of the Royal Colleges of Physicians and Surgeons, for investigations as to improved means of treating horses with a view to obtaining diphtheria antitoxic serum in a shorter time than is possible by the methods hitherto in use.

OUR contemporary *Invention* has lately been brought out in a popular penny series. We hope and believe that in this form it will play a useful part by showing to a wide circle of readers some of the work that has been, and is being, done in the world of science, and by indicating how intimately scientific research is connected with industrial progress.

WE notice with regret the death of Mr. J. Traill Taylor, editor of the *British Journal of Photography*. He was in his sixty-ninth year, and was widely known and respected in photographic circles. We have also to record the death of Prof. George Lawson, Professor of Chemistry and Mineralogy in the University of Halifax, Nova Scotia, and formerly President of the Royal Society of Canada.

THE death is announced of Surgeon-Major George Edward Dobson, F.R.S., at the age of forty-seven. He was awarded the gold medal of the Dublin Pathological Society in 1867 for his essay on the diagnosis and pathology of the injuries and diseases of the shoulder-joint. He also wrote "Medical Hints to Travellers," published by the Royal Geographical Society;

"Monograph of the Asiatic Chiroptera," 1876; "Catalogue of the Chiroptera in the British Museum," 1878, a complete natural history of the order; and "Monograph of the Insectivora, Systematic and Anatomical," in which the zoology and anatomical structure of the species were concurrently investigated; and he was the author of numerous other articles, published in the *Proceedings* of various scientific societies and in scientific journals. He was elected into the Royal Society in 1883, and was a corresponding member of the Academy of Natural Sciences of Philadelphia and of the Biological Society of Washington.

A GREAT Frenchman has just passed away in the person of M. Barthélemy Saint-Hilaire. He was born so far back as August 19, 1805, and the fiftieth anniversary of his election into the Academy of Moral and Political Sciences was celebrated in 1889 at the Institute of France. Like many other men in France, he was both philosopher and statesman. He translated the complete works of Aristotle, and was the author of numerous original works. He spent some time in a journey to Egypt with M. Ferdinand de Lesseps, to explore the Isthmus of Suez; and he shared to the full the firm belief of the creator of the Suez Canal in the feasibility of the undertaking. After his return from Egypt he published his "Letters on Egypt," 1856, and "Egypt and the Great Suez Canal," 1857. In 1860 M. Saint-Hilaire published his work on "Buddha and his Religion"; in 1865 appeared his "Mahomet and the Koran," preceded by an introduction on the Mutual Duties of Philosophy and Religion, and in 1866 his "Philosophy of the Two Ampères." He was Secretary-General of the Presidency of the French Republic, after the war of 1871. Upon the fall of M. Thiers, he resumed his great translation of Aristotle. In 1880, at the age of seventy-five, he became Minister for Foreign Affairs in the Jules Ferry Cabinet, from which he retired on the accession to power of Gambetta in 1881.

A COMPLETE change in the type of weather took place over the British Islands during the latter part of last week. The *Daily Weather Report* of the 23rd inst. showed that an area of high barometric pressure was spreading over our western coasts from the Atlantic, while an area of low barometric pressure, which had formed over the North Sea, was crossing the Netherlands. During the following days this disturbance passed to the south of Italy, and, in connection with very high barometer readings in Scandinavia, its passage caused strong north-easterly and easterly gales in the south and east of England, and very high seas in the English Channel, while on the continent it was accompanied by much snow and sleet. Although the force of the wind was not so strong inland, the pressure recorded at Greenwich Observatory on Sunday was 16 lb. on the square foot, which by the revised factor for the conversion of wind pressure to velocity is equivalent to a rate of about 76 miles in the hour.

THE terms of the competition for the Thousand Guinea Prize offered by the *Engineer* for mechanical road carriages are published in the current number of our contemporary. The limit of weight has been fixed at two tons, and the speed at ten miles an hour; while in the case of oil being used as the motive power, the flashing point is fixed at 73° F. The competition, it is thought, cannot take place before October 1896, when the various vehicles—two classes of two tons each, and two of one ton each—will be required to run 200 miles, and Sir F. Bramwell, Mr. J. A. F. Aspinall, and Dr. John Hopkinson will act as judges.

THE convention between Italy and Switzerland for the construction of the Simplon Tunnel was signed at Berne on Monday. The programme of the works to be followed is that already approved by the Jura-Simplon Company, the Swiss Federal Council, and the Italian Government. When the tunnel is completed, the nearest seaport for French Switzerland, Haute Savoie, and the Valais will no longer be Marseilles, but Genoa, and the shortest route from Milan, Piacenza, Venice, Genoa, and Trieste to Paris will be through the tunnel.

WE learn through the *Times* that the United States Nicaragua Canal Commission, appointed by President Cleveland last spring, has reported that it is neither advisable nor practicable to attempt the construction of a canal upon the data at present available. New surveys are needed before any final judgment can be formed, but the provisional estimate of the cost by this Commission is about £27,000,000, nearly double the Maritime Canal Company's conditional estimate. That Company's report is very strongly criticised in detail and in general, to the effect that it is not based on a thorough knowledge of the physics of the site. Their proposed dam in Ochoa is regarded as unsafe, dangerous, and subject to floods, the proposed entrance to Greytown Harbour is deemed wrongly placed, and the canal itself is considered inadequate in width and depth. The numerous technical criticisms of this report all point in the same direction—namely, that no such canal as that contemplated by the Maritime Company can be built in the way which they design, or for the money which they would expend upon it.

THE opening meeting of the Conference convened by the Board of Trade on the subject of the revised regulations proposed to be made under the Electric Lighting Acts, 1882 and 1888, was noted in our last issue (p. 60). We extract from the *Times*' report of the second day's proceedings the more important decisions arrived at. The Chairman, Sir Courtenay Boyle, stated that he had carefully considered the very important representation made the previous day on the subject of the definition of low pressure, and he thought it would be for the convenience of those interested if a decision were reserved for a short time, so that the Board of Trade might appoint a small committee, not exceeding three, of expert advisers, carefully to consider the scientific aspect of the question, and to make a suggestion to the Department. This was approved by the meeting. The discussion of Clause 35 of the revised regulations relating to street boxes, pointed to the need for a definition of street boxes, and led the Chairman to suggest that the clause should apply only to street boxes containing transformers. It was agreed that the clause should read thus: "In the construction of street boxes used as transformer chambers reasonable means shall be adopted to prevent as far as possible any influx or accumulation of gas or water either from the adjacent soil or by means of pipes; and ample provision shall be made by ventilation or otherwise for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking." The Chairman promised to consider whether the Board of Trade could make a regulation for the ventilation of street boxes of a certain dimension. Opposition was offered to Clause 37, which provided that "the casing of any high-pressure electric lines shall be continued within street boxes," and the Chairman said the clause would be struck out on the understanding that it might be necessary to continue the old regulation, so as to prevent danger arising by high-pressure lines passing through transformer chambers not being properly cased. Objections having been raised to Clause 38, relating to converting stations, the Chairman said he thought the old regulation would better meet the case. That regulation was as follows: "Converting stations, or points in a system of distribution to which a high-pressure supply is given from generating stations, and from which a low-pressure supply is given to one or more consumers, and which are not on the consumer's premises, shall be established in suitable places, which are in the sole

occupation and charge of the undertakers." After discussion the Chairman accepted Clause 41 in the following form: "A suitable safety fuse or other automatic disconnector shall be inserted in each service line as close as possible to the point of entry in any consumer's premises, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box." A few other regulations having been discussed, the proceedings of the Conference terminated.

A RARE British bird invites the attention of ornithologists in the Fish House of the Zoological Society's gardens. This is a Spotted Redshank (*Totanus fuscus*) in winter plumage, recently obtained from the fens of Lincolnshire, being the first individual of this species that has been received by the Society.

IT is well known that liquid ammonia relieves the effects of the stings of bees. A correspondent informs us that a much more effectual antidote is the mixture known as ammoniated tincture of quinine. On several occasions, when stung by bees, he found that the quinine mixture would give much quicker and greater relief than ammonia alone.

WITH reference to their letter on the thermal conductivity of rocks, published in our issue of the 7th inst., Messrs. Peirce and Willson desire to say that the phrase "recent discussion in NATURE" refers to communications printed in these columns previous to June 20. When they wrote their letter, they had not seen the account of the experiments of Lord Kelvin and Mr. Murray, published in NATURE of that date (vol. lii. p. 182).

A CORRESPONDENT writes:—"On November 19 of this year, some yardsmen were turning over some English oak planks, prior to stacking them, at Messrs. Harry Hems and Sons at Exeter, when one of the men put his hand in a knot-hole that occurred in a 6-inch thick plank. He instantly withdrew it with a cry, and some wasps flew out. On examination, the hole was found to contain a large nest with sixty or seventy wasps in it. The plank and its living contents had come, with a number of others, from Lincolnshire by rail a few days before. Probably this long ride for a wasp's nest beats the record!"

SOME of the officers of the new Ashantee Expedition, who have leisure for sporting pursuits on their march up to Coomassie, will do well to secure for the National Collection additional specimens of the Royal Antelope (*Neotragus pygmæus*), which are much wanted. This little animal, discovered by Bosman in 1704, and named the "King of Harts," and subsequently figured in Seba's "Thesaurus," although so long known to science, is still a scarce object in our museums. In fact, as Messrs. Sclater and Thomas tell us in their "Book of Antelopes," all the small members of this group, both of West and East Africa, are still very imperfectly known, and additional specimens and information on them are much required.

IN the course of his researches on the smaller mammals of South America, Mr. Oldfield Thomas, of the British Museum, has made a brilliant discovery. A small rodent, not quite so big as a rat, which he has lately named *Cænolestes obscurus*, turns out to be closely related to, and a surviving representative of, some of the Fossil Marsupials recently described by Ameghino from the Santa Cruz beds of Patagonia. It therefore belongs to a new family, quite distinct from all hitherto known existing forms of the Marsupial order. Mr. Thomas's paper on this subject will be read at one of the Zoological Society's next meetings.

"CARBONIC snow," or carbonic acid crystals, form the subject of an interesting paper by MM. P. Villard and R. Jarry in the November number of the *Journal de Physique*. Using a toluene thermometer, they found that in the open air it kept at a constant temperature of $-79°$ C. This is in fact its boiling point, but whatever liquid is formed is at once frozen by the cold caused by evaporation. Hence the gas is only slowly given off. To prevent radiation, it should be kept in a glass silvered on the outside. The solid "snow" is, by the way, heavier than the liquid carbonic acid, in spite of its apparent lightness. No hoar-frost forms on the surface, owing to the constant evolution of the gas. Another vexed question is that of the temperature of the solution of the "snow" in ether. Accurate measurements showed that, contrary to the popular idea, this solution is not a freezing mixture, its temperature being $-79°$ C., the same as that of the solid. Methyl chloride does, on the other hand, form a freezing mixture of the temperature $-85°$ C. In a flat dish this becomes $-88°$ C., and when a current of air is blown through, $-90°$ C. In a vacuum of 5 m.m. of mercury, the temperature falls as low as $-125°$ C. Since this is below the critical temperature of oxygen, there seems no reason why oxygen should not be liquefied by the aid of carbonic acid alone.

THE common crow has a bad reputation among agriculturists, but a report, by Prof. W. B. Barrows and Mr. E. A. Schwarz, on his habits in the United States (*Bulletin* No. vi., U.S. Department of Agriculture), shows that even his character is not so black as it has been painted. The most important charges brought against the crow are that it pulls sprouting corn, injures corn in the milk, destroys cultivated fruit, and feeds on the eggs and young of poultry and wild birds. All these charges are sustained by the results contained in the present report of the examination of the contents of nearly a thousand Corvine stomachs. Crows do certainly feed upon the substances named, but the extent of the injury they do is quite another matter. In order to ascertain whether the sum of the harm done outweighs the sum of the good, or the contrary, the different kinds of food found in the stomachs have been reduced to quantitative percentages, and then compared. The results show that only 3 per cent. of the total food of the crow consists of sprouting corn and corn in the milk; the remaining 97 per cent. is chiefly waste grain picked up here and there, mainly in winter, and of no economic value. In the case of cultivated fruits, the loss due to crows appears to be trivial. The same is true of the eggs and young of poultry and wild birds, the total for the year amounting, in the cases examined, to only 1 per cent. of the food. As an offset to his bad habits, the American crow is credited with the good done in destroying noxious insects and other injurious animals. Insects form 26 per cent. of his entire food, and the great majority of these are grasshoppers, beetles, weevils, cutworms (larvæ of Noctuidæ), and other injurious kinds. To the same side of the scale must also be added the destruction of mice, rabbits, and other injurious rodents by the crow. Wherefore Mr. Hart Merriam concludes, in his introductory note to Messrs. Barrows' and Schwarz's valuable report, that, in summing up the benefits and losses resulting from the food habits of this bird, the good exceeds the bad, and that the crow is a friend rather than an enemy of the farmer.

THE efficiency of windmills and agricultural apparatus forms the subject of a note, by Prof. Cleveland Abbe, in the *Monthly Weather Review*. There are many important and expensive agricultural machines, such as reapers, mowers, windmills, and pumps, to say nothing of portable steam-engines, that are needed on large farms, or the centrifugal separators used in dairies, that fail to give satisfaction because of some inherent mechanical defect. The most efficient machine is that which produces the best result with the least possible waste of power. Prof. Abbe suggests that there be some recognised authority to come between the manufacturer and the farmer; some one who shall "standardise" any piece of apparatus when desired, and

certify as to the amount of power that is lost, or as to the efficiency of the machine when working under its best possible condition. Mechanical engineers are accustomed to determine very accurately the relation between the work done and the force expended; but no arrangement has yet been organised in America, though in England the Royal Agricultural Society does something by means of which the farmer may obtain, for a small fee, accurate information as to the efficiency of the windmills, pumps, and other apparatus used by him. Such tests are sometimes applied, but oftentimes imperfectly, to machines that are offered in competition for prizes at shows; but the results apply only to those specific samples, and not to others that are ordinarily found in the market. There are standards for the sale of illuminating gas, electricity, and other sources of energy. The time may come, concludes Prof. Abbe, when Governments will standardise and regulate the sale of the machines for the conversion of force or the doing of work.

THE current number of the *Journal de Physique* contains a description of an instrument for measuring the specific inductive capacity of liquids or solids, designed by M. Pellat. The instrument consists essentially of two Kelvin attracted disc electrometers, in which the two movable discs are rigidly connected together. The two attracting discs are in metallic connection, and one of them can be moved by means of a micrometer screw. The attracted discs are attached to the arm of a delicate balance, the position of the beam being observed by a microscope. An air damper attached to the beam serves to check the oscillations, which otherwise would render the measurements extremely tedious. Weights are used to roughly counterpoise the weight of the attracted discs when the whole instrument is at one potential. The final adjustment is made by means of a fine spiral spring, attached to the arm of the balance, and which can be stretched more or less by means of a micrometer screw. This spring has the advantage of increasing the range of potential difference over which the position of the balance is stable. The substance to be examined—if a solid in the form of a slab, or if a liquid contained in a glass dish—is placed between the fixed attracting disc and its movable disc, being supported on three small glass blocks which rest on the guard-ring. Readings of the position of the movable attracting disc are taken with and without the substance in place, and from the difference of the readings the specific inductive capacity is calculated. The sensitiveness of the instrument is such that the author has been able to measure, roughly it is true, the specific inductive capacity of mica, using a plate of this substance only 0·013 c.m. in thickness. In the case of liquids, measurements have been made in which the one set of plates, attracting plate, attracted plate and guard-ring, were entirely immersed in the liquid. The effect of capillarity on the stem joining the two attracted discs was to very much increase the range of potential difference giving stability of the balance. It was found that at the moment of applying the difference of potential an initial and very sharp movement always takes place when the balance is not perfect; so that the measurements could be made with an accuracy as great as in the case of solid dielectrics.

WE have received from M. A. Lancaster, of the Royal Observatory, Brussels, a pamphlet containing his communications to the Congress of the Science of the Atmosphere, held at Antwerp last year: (1) On synoptic weather charts, advocating the establishment of an international meteorological institute, acting on the part of all countries, and the pubiication of weather charts for extensive areas. The question of an international institute for meteorology has frequently been discussed, and at the recent meeting of the International Meteorological Committee at Upsala it was decided that the idea was not practicable. But the author points out that in the cases of geodesy and metrology such institutions have long been established. (2) On the nature of the wind. The principal object of this paper is to draw attention to the similarity of the views of the late M. Houzeau (formerly director of the Brussels Observatory) to those of Prof. S. P. Langley, expressed in his treatise on the internal work of the wind (NATURE, vol. xlix. p. 273), in which he shows that the wind consists of a succession of pulsations of very short duration, of variable amplitude and direction, relatively to the mean movement of the wind. (3) On the strength of the wind in Belgium. This paper contains tables of the principal results of observations at Brussels from 1850 to 1889, showing *inter alia* the mean monthly velocity, the bi-hourly variation, the maximum velocity and its direction in each month. These tables afford valuable information for architects and engineers, and for any one requiring details as to the effect of the motion of the atmosphere.

RESPONSIBLE measle-microbes, although suspected, have long eluded the diligent search of the investigator. Dr. Joseph Czajkowski, however, appears to have opened up the subject afresh by bacteriological researches which he has been carrying on for nearly four years on cases collected from four different epidemics of measles. Although the total number of cases bacteriologically examined was not great, amounting to only fifty-six in all, yet in every instance the same microbe was identified from the blood of measle patients, and is described as being a somewhat slender bacillus with blunted ends, producing occasionally threads in cultures some months old. No difficulty is experienced in staining it with the usual aniline colours, and in drop-cultures it is seen to be very motile. Gelatine and agar are not suitable for its growth; on the other hand, glycerin-agar and broth form convenient culture materials. As regards the pathogenic properies of Dr. Czajkowski's bacillus, the information is only at present limited to its action on rabbits and mice. The former experienced no inconvenience whatever after being inoculated with it, but the mice died in from three to four days, exhibiting symptoms of septicæmia, and the same bacillus was subsequently obtained in pure cultures from the blood, spleen, and liver of the infected animals. Perhaps the strongest evidence in favour of the author's researches is to be found in the fact that two other investigators, P. Canon and W. Pielicke, working at the subject quite independently of Dr. Czajkowski, discovered the same bacillus. Further inquiries must, however, be made before we can define with certainty the precise relationship to measles possessed by this new microbial claimant.

THE last number of the *Mittheilungen von Forschungsreisenden und Gelehrten aus den Deutschen Schutzgebieten*, Bd. viii. Ht. 3, continues the scientific description of the German colonies. The first contribution deals with the Hinterland of the Cameroons, from materials collected during Dr. Passarge's expedition during 1893 and 1894. Schnauder has worked out a series of twenty longitudes. Passarge gives the data on which the altitude determinations rest, and some of the results. Dr. Limpricht has prepared three maps of the district on the scale of 1 : 350,000, and connected Passarge's routes with those of previous travellers in this region, viz. Barth, Flegels, Maistre, Zintgraff, and Baikie. The second contribution in the number is Stühlmann's description of the Uluguru Mountains, a district in German East Africa between Usambara and Usagara, and about one hundred miles inland. Geologically it consists mainly of gneiss, with some clay-slates, oolitic limestones and red sandstones, on the plains at the eastern foot of the mountains. Mica and graphite were the only minerals found, which Dr. Stühlmann thinks may be of economic value. The gneiss forms a plateau, to the east of which are the steppes of the "Vorland." The former is regarded as healthy and free from malaria. The author of this report has previously expressed the belief that

the climate of eastern equatorial Africa was more humid than at present: he now attributes the change to artificial deforestation of the country. The most interesting paper in the number is one by St. Paul Hilaire, which gives an account of the laws of inheritance of the different tribes on the coast near Tanga. In the actual coast towns the people are either Mohammedan, or under Mohammedan influence, and the author has little new to record, except a list of native writings. The Bantu people of the district considered belong to four tribes, of which the report deals only with the Wa digo, one of the most intelligent people on the East African coast. St. Paul-Hilaire first states the laws on the inheritance of property, which passes to the relatives of the mother. Thus a man's wives and children are inherited by the nearest male maternal relative. The rest of the report summarises the rules in regard to marriage. The last article in the volume continues the publication of Dr. Steinbach's important meteorological observations on the Marshall Islands.

FOR several years the American Public Health Association has had a special committee on pollution of water supplies. At the meeting of the Association in Montreal, this committee recommended that a co-operative investigation be instituted with regard to the bacteriology of water supplies, and, as an outcome of this proposal, a convention was held in New York, in June last, to consider methods and elaborate a standard scheme of work which would secure some sort of uniformity in the differentiation of species of bacteria. The verbatim report of the proceedings of this convention (which was attended by most of the prominent American bacteriologists), together with the papers presented, make up the October *Journal* of the Association. The subjects considered relate almost exclusively to certain technical matters, which required elucidation before a satisfactory scheme of work could be drawn up; among these questions being: colour nomenclature for bacteriologists; how variability is to be regarded; the methods to be followed in determining the relation of bacteria to temperature; methods for the separation of bacteria into groups, and for the identification of species; the nature of the flagella, and their value in the systematic classification of bacteria; the grouping of water bacteria, and the influence of variations in the composition of nutrient gelatine upon their development. No decision was reached on any of the questions discussed; but the whole series was referred to a committee, with the understanding that the convention would accept its decision, and that its members would modify their laboratory methods in accordance therewith. The decisions of this committee have not, however, yet been published.

THE literature of marine biology has just been increased by the publication of the fourth volume of "Reports upon the Fauna of Liverpool Bay and the neighbouring Seas," written by the members of the Liverpool Marine Biology Committee and other naturalists, and edited by Prof. W. A. Herdman, F.R.S. The volume commences the record of the investigations carried on at the committee's biological station at Port Erin, Isle of Man. At this station, which was opened in 1892, several important investigations have already been carried out, and there is every reason to believe that the work will develop in the future, as the facilities for observations are increased. We notice among the papers included in the volume, one on the vascular systems of the Starfishes, by Mr. H. C. Chadwick, and another on the Cerata of Nudibranchs, by Mr. J. A. Clubb. There are also reports on Turbellaria, by Mr. F. W. Gamble; on Copepoda, by Mr. Isaac C. Thompson; on Nemertines, by Mr. J. H. Vanstone and W. I. Beaumont; on Medusæ, by Mr. E. T. Browne; and on Amphipoda, by Mr. A. O. Walker. These, with a valuable paper, by Dr. R. Hanitsch, on the nomenclature and classification of British sponges, and three reports, by Prof. Herdman, upon the work of the Liverpool Marine Biology Committee and their biological station, make up a very creditable volume. The Liverpool naturalists deserve to be congratulated for accomplishing so much work in a modest establishment, and without any funds except those raised by private subscriptions.

TWO memoirs on Entomophytes have recently been published. The one is by Mr. R. H. Pettit on "Studies in Artificial Cultures of Entomogenous Fungi," and emanates from the Cornell University Agricultural Experiment Station, U.S.A. The other is by Mr. A. S. Olliff on "Australian Entomophytes, or Entomogenous Fungi, and some account of their Insect-Hosts," and is issued by the Department of Agriculture, Sydney, N.S.W. Both are well illustrated, and deal largely with Cordyceps and Isaria. The loose, white, cottony growth which sometimes envelopes dead insects is a familiar sight, and Mr. Pettit, in discussing the possible use of entomogenous fungi for insecticidal purposes, refers to the suggestion that has been made to employ *Sporotrichum globuliferum* against the chinch-bug. Mr. Olliff is prepared to make the assertion that all the larger fungi of the genus Cordyceps live upon, and at the expense of, subterranean larvæ and pupæ, in proof of which he points to the fact that all the bulky species of which the hosts are definitely known have been found upon root-feeding insects. Of Hyphomyceteæ there are various minute entomogenous forms recognised as Australian. Some of these are variously found on aphides infesting pumpkin leaves, on dead ants, and on red scale of the orange. *Botrytis tenella*, Sacc. (*Isaria densa*), on larvæ and pupæ of Diptera, wasps, and cockchafers, has been introduced into Australia from Europe for the purpose of killing Lamellicorn larvæ, but the attempts have not succeeded. Mr. Olliff adds that in view of the large numbers of *Cordyceps Gunnii*, and *C. Selkirki* that are found in a limited area, and of the extensive injuries to useful timber and shade trees which often result from the attacks of the subterranean larvæ of Pielus and Trictena, the hosts of these parasitic fungi, it is evident that the native species of Cordyceps have a considerable economic value. He hopes that the Department of Agriculture at Sydney will shortly be able to make investigations to test the possibility of utilising these fungi artificially for the destruction of injurious root-feeding insects.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. V. Roger; a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, presented by Major F. A. White; a Kittiwake (*Rissa tridactyla*), British, presented by Mr. Walter Butters, jun.; three Poë Honey Eaters (*Prosthemadera novæ-Zealandiæ*) from New Zealand, presented by Mr. Morton Campbell; a Bearded Lizard (*Amphibolurus barbatus*), a Diamond Snake (*Morelia spilotes*) from Australia, presented by Mr. Frederick G. Aflalo; a Four-lined Snake (*Coluber quadrilineatus*), European, presented by Captain Allen Keys; a Poë Honey Eater (*Prosthemadera novæ-Zealandiæ*) from New Zealand, deposited.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A bright comet was discovered by Mr. Brooks, at Geneva, on November 21, in R.A. 9h 52m. and Decl. 17° 4′ S. An observation of the comet at Copenhagen shows that it is moving northwards at the rate of nearly three degrees per day. On November 24, at 17h. 37m. 9s., it was in R.A. 9h. 42m. 33s. and Decl. 10° 40′ 32″ S. The comet is not far from α Hydræ, and rises about 12.30 a.m.

COMET PERRINE.—The comet discovered by Mr. Perrine at the Lick Observatory, on November 16, was observed by Dr. Lamp at Kiel, on November 18, its position at 17h. 34·2m. Kiel mean time being R.A. 13h. 48m. 8s., Decl. 0° 50′ 24″ N. *Edinburgh Circular* No. 47 reports that the comet was also

observed by Dr. Halm, at Blackford Hill, as follows:—November 18, 18h. 26m. 14s. G.M.T.; R.A. 13h. 48m. 15s., Decl. 0° 48′ 18″·8 N. The movement of the comet is in a direction south-east by east, and it now rises about 4 a.m. Dr. Lamp states that the comet is moderately bright, but not visible to the naked eye; it is round, with a central condensation, and a straight tail (*Ast. Nach.* 3318).

VARIABLE STAR CLUSTERS.—Harvard College Observatory *Circular*, No. 2, announces that an extraordinary number of variable stars has been discovered in certain globular clusters which have been photographed by Prof. Bailey at Arequipa with the 13-inch Boyden telescope. At least eighty-seven of the stars in the cluster M3 (N.G.C. 5272), in Canes Venatici, have been found to be variable, and in some cases the change of light amounts to two magnitudes or more. In the cluster M5 (N.G.C. 5904), forty-six variables were found, out of 750 stars examined, so that they form about six per cent. of the whole; of the sixteen stars, contained in a circle 110″ in diameter, six are variable. Smaller numbers of variables have been found in other clusters, but in other cases not a single variable has been detected out of the hundreds of stars which have been photographed: the conditions of the search, however, not taking account of long period changes. In general, no variables have been found within about one minute from the centres of the clusters, on account of the closeness of the stars, and none are more than ten minutes distant from the centres. Some of the newly-discovered variables have short periods, in some cases of only a few hours. Thus, five photographs of N.G.C. 5904, taken at intervals of an hour on July 1, 1895, give for the magnitude of a star about three minutes of arc preceding the centre of the cluster, 14·3, 13·5, 13·8, 13·9, and 14·3: four plates, taken at similar intervals on August 9, gave the magnitudes 14·2, 14·6, 14·8, and 15·0.

ON A METHOD OF PHOTOGRAPHY IN NATURAL COLOURS.[1]

IN 1861 Clerk Maxwell described a method of colour photography, based upon his experiments on the theory of colour vision, and made the following experiment. Three photographs of a coloured object were taken through three several coloured solutions giving images which separately represented the object as it would be seen by each of the three sets of colour nerves postulated by Young. When these were superposed the original colours of the object were reproduced, save for the defect that the red and green components suffered from the insensitiveness of the photographic plate of Maxwell's time to the longer wave-lengths. Maxwell added the remark that when the photographic plate was improved as regards sensitiveness to the less refrangible rays, the representation of colour would be improved.[2]

Since Maxwell's day the colour blindness of the plate has been almost completely remedied, thanks to the discovery of Vogel, and it is now possible, proceeding on the lines laid down by Maxwell, to produce by triple projection upon the screen a picture which may be illusively like nature. For the application of modern resources and the suggestion of photographing to the colour vision curves by special colour screens, we have to thank Mr. Ives.

Composite colour photography deals with the subjective reproduction of all visible wave-lengths in two stages; a photographic analysis and an optical synthesis. In the first operation the several wave-lengths are caused to produce three separate photographic images according to their physiological activity in exciting the supposed fundamental red, green, and violet sensations. That is, if the image bears, for example, a yellow colour (suppose such a yellow as the spectral yellow near the D line), one of the plates must record an image of the object having a density of silver deposit corresponding to the degree in which this wave-length can excite the red-seeing nerve, and a second must acquire a density corresponding to the degree in which this same wave-length can excite the green-seeing nerve. The third plate records no impression, for the wave-lengths near D excite no violet sensation; but this yellow sensation is the resultant of two physiological effects only, a red and a green sensation in certain proportions obtained by colour measurements effected upon normal colour sight. We have now obtained three negatives possessing densities of silver deposit corresponding to the degrees in which the three several fundamental colour sensations are stimulated. These degrees of density will be interpreted as degrees of transparency in the positives. The first positive, if backed with a red glass, will transmit a quantity of red light corresponding to the intensity of the physiological excitation of redness in the "red" nerves; the second, backed with green, similarly represents the stimulation of the "green" nerves by the yellow colour of the object; the third positive is backed with blue-violet glass, but is quite opaque, and no violet light is transmitted through it. The projection now of all three images superposed upon the screen forms the second stage of the procedure; the optical synthesis of the original colours. The eye regarding the superposed image receives, in fact, the same amounts of red and green sensation, and experiences the same absence of violet sensation which would have attended the formation of the image of the original object upon the retina.

This process, if accurate reproduction of colour is sought, necessitates the use of two distinct sets of colour selective screens; for the analysing screens will by no means possess the tints ultimately required in the optical synthesis. This is evident since the measurements on colour vision reveal that the wave-lengths near D are more strongly stimulative of red sensation than are the purely red exciting wave-lengths near C, and the wave-lengths again diminish in their power of producing stimulation of the "red" nerves on the more refrangible side of D. Hence, in order to photograph the wave-lengths of the spectrum, we require to produce a greater photographic effect by the D wave-lengths than by the C wave-lengths, and a photographic

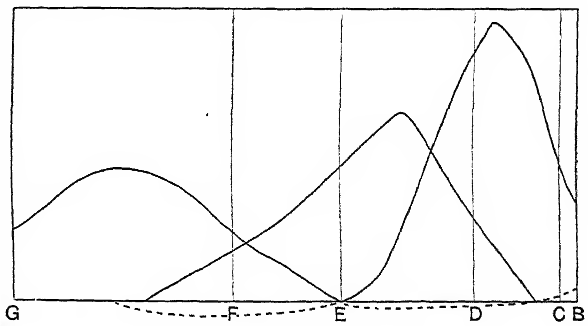


FIG. 1.

effect diminishing above D in the same degree as the power of the waves to excite the fundamental red sensation diminishes. To effect this analysis of the light a screen transmitting as predominant wave-length, a wave-length near D must be used for obtaining the image which is to represent the appreciation of light peculiar to the "red" nerves. Such a screen has a yellow-orange colour, which is not the sensation excited in or transmitted by the "red" nerves. In the optical synthesis this must afterwards be represented by a C red colour. The same remarks apply to the other screens.

Maxwell's curves (Fig. 1) are not colour sensation curves (Abney: "Colour Vision," Tyndall Lectures, 1895), and it is misleading to speak of the foregoing method as effected on colour sensation curves. Maxwell's curves represent, in fact, the subjective synthesis of the spectrum out of three chosen wave-lengths—a red, a green, and a blue-violet. The question as to how far one or all these chosen wave-lengths may excite more than the one set of nerves remains over, and indeed can only be gone into by examination of abnormal colour vision. In Kœnig's curves of colour vision, colour sensations are plotted. These are shown in the named curves of Fig. 2.

If, from the knowledge afforded by Kœnig's curves of the compound nature of the green sensation, Maxwell's curves be examined with reference to their suitability to serve the purposes of the photographic method, it will be found that, assuming Maxwell's E green to excite the proportionate amounts of red and violet sensation revealed by Kœnig's curves, a correct synthesis of the F green by Maxwell's curves is impossible. Although such a comparison is not strictly allowable owing to

[1] Abstract of a paper read before the Royal Dublin Society, by Dr. J. Joly, F.R.S.
[2] "On the Theory of Three Primary Colours." "Collected Papers," p. 449.

the red and violet curves of Maxwell being based on different wave-lengths to those used by Kœnig, the fact of grave inaccuracy is certain. This fact will appear if the spectrum is photographed according to Maxwell's curves. The blue-green will then be found to be reproduced too yellow in tone.

In order to apply the colour sensation curves of Kœnig to the photographic method, we have to find by trial examinations of his curves the green most suitable for backing the "green" positive; for we see that the several green wave-lengths excite very different amounts of red and violet sensation. We find as suitable a wave-length a little to left side of the E line, about 550 $\mu\mu$. If we take this colour to back the green positive, we must, in order to find the correct red and violet curves which are to control the densities of the red and violet images, replot the red and violet curves with allowance for the proportionate amounts of red and violet which will be carried to all those points where in the image of the spectrum the green curve operates. The red and violet curves must be lowered by amounts obtained by ascertaining from the height of the green curve at any point the amount of red and violet sensations excited by the amount of our selected green present at that point. The final curves are shown in the slightly altered violet sensation curve, the original green sensation curve, and the considerably lowered red-mixture curve (as it may be called); the full line in all cases representing the applicable curves. It is seen that the amount of negative colour (which cannot be realised) is small. Although it is possible that the compound nature of our green sensations will deny absolute accuracy to this method of colour photography, still my own results on the curves just described, and the results of Ives and others on modified Maxwell curves, appear to show that a degree of accuracy baffling the criticism of the ordinary untrained eye may be attained, and that in the reproduction of the most complex tints.

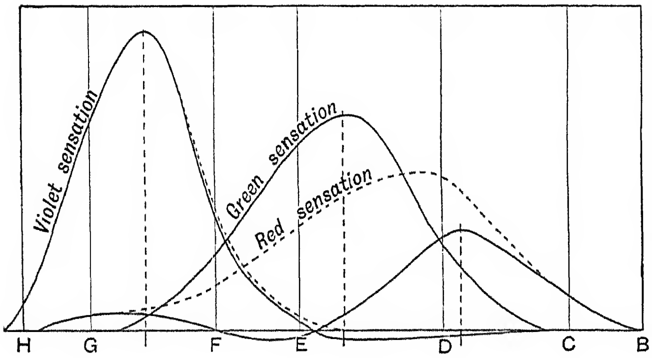


FIG. 2.

The symmetry of the derived curves renders their application easy. The transmission of light through a pigment is not limited generally to a small group of predominant wave-lengths, but falls off uniformly at either side in the directions of longer and shorter waves. If we choose the pigments used on the analysing screens so that their predominant transmissions are at three points in the spectrum indicated by the axis of symmetry of the three curves, these being nearly symmetrical, very accurate results are obtained. The positions of these axes of symmetry are shown by the vertical dotted lines. Accordingly, I make the colour of the red-taking screen that of the spectrum at a point displaced to the red side of D by about one-sixth the interval D to C; for the green and violet-taking screens the correct tints are found in the same manner by scaling from the figure. Good results are thus obtained, but I do not assert that these details of procedure are final.

Any method of photography in natural colours must possess the characteristics not only of accuracy of colour rendering, but also of convenience of application and permanency of colour, if it is to possess value as a scientific method. For use under the various circumstances of travel the naturalist requires a method no more cumbersome than the present dry plate. In the method of composite colour photography, as described, the ordinary camera will not serve. The cumbersome necessity of obtaining three images remains, and subsequently no concrete image in natural colours is actually obtained. One can only be realised by triple projection upon a screen, or by using some optical contrivance which, by the aid of reflectors, enables all three images to be simultaneously projected upon the retina.

I now proceed to describe a mode of applying the foregoing principles which is free of the objection of cumbersomeness, and which enables us to realise a concrete image in transparent colours. A plate is finally produced which may be held in the hand, regarded against the light, and which bears an image of the object in natural colours, or such as are so nearly accurate as to seem so to the eye. In this new method there is but the one image photographed. The ordinary camera, lens, and backs, &c., are used without modification. The first-class isochromatic plates in the market, which are sensitised down to the C red, will give very good results.

In the new method the idea is to carry the application of physiological principles still further, and divide up the plate like a hypothetical subdivision of the retina, so that all over the plate there should be minute regions uniformly distributed wherein the sensitive silver salt is excited to become reduced to the "photogenic" material in the same degree in which the sensations of redness, greenness, violetness, would have been actually excited in the several nerves of the retina had the image been formed upon it. Development builds upon this photogenic material the denser silver deposit, and ultimately in the positive the amounts of the sensations are registered in the degrees of transparency of the successive regions. The lined screen which can bring about this I can show you in the microscope. It consists of closely ruled adjacent lines in orange, green and violet tints. This screen, applied closely to the sensitive surface, analyses the image in the camera. The screens I have used hitherto are coarse, about 200 lines to the inch, and even with this coarseness will show plainly, I regret to say, the imperfections of the only apparatus at my command in preparing these screens. I may observe, in passing, that the colours are ruled on in pigments made up as inks in gelatine and gum arabic or dextrine, and upon plates coated with a preliminary layer of gelatine. Such lines may be put on so close as 800 or 1000 to the inch. With between 300 and 400 to the inch, however, the eye is no longer annoyed by the structure of the plates. The lines may also be ruled on celluloid or on translucent paper.

The appearance of both negative and positive obtained is interesting. One would hardly at first sight distinguish between them and the ordinary images. But a lens readily shows the difference. Recalling now that the lines upon the positive register in their degrees of transparency the degrees in which the three-colour sensations would have been excited, it becomes apparent that to complete the physiological parallel we must convert these degrees of transparency to quantities of the red, blue and violet colour sensations. This is done by a second screen, which carries red, green and violet lines to the same gauge as the taking screen. We apply this to the positive, and as we move it over the image, waves of every tint of colour appear till that position is reached where the red lines fall over the lined areas recording red sensation, and so for the others. The picture now suddenly appears in vivid colour and with all the realism and relief conferred by colour perspective.

A picture of wallflowers taken through a dichromatic screen, the red and green sensations only being photographed, is of interest as realising the appearance of the object to a violet-blind eye. The rich reds and browns appear unaffected; the greens are, however, somewhat unnatural. A photograph of the spectrum shows the range of colour from the C red to the H lines. The blue-green is, however, defective. It was taken according to Maxwell's curves. Photographs of burnished metallic objects, as a brightly lacquered microscope, reproduce the metallic lustre; and one of an uranium glass bowl, reproduces the characteristic dichroism and fluorescent appearance of the glass when seen by daylight. That every shade of colour can be reproduced, however complex, is shown by two portraits, one from life, and one a copy of a water-colour drawing boasting very æsthetic shades of brown and olive. A great variety of bright sunlit colours appear in a view at the Trinity College athletic sports, wherein the scarlet uniforms of the military band, the green of the grass, and the blue sky, recall the vivid appearance of the image on the ground glass screen of the camera. The colour perspective in such pictures adds greatly to the reality and relief. The faithful reproduction of texture, as in the case of some pansies, where the velvety browns and purples of the originals reappear, or as in the case of the wallflowers, reminds us how much is

inferred from the most subtle differences of light and shade in the colours of objects, in association with previous experience derived through other senses. The picture is always an optical illusion; and this additional illusiveness conferred on the photograph by the method invented by Maxwell on the basis of the three-colour theory of vision, is surely a strong confirmation of that theory.

These results are attained by no new photographic operations. It is necessary to use good orthochromatic plates sensitised into the red, and also to have affixed in the lens an orthochromatic screen cutting of the ultra-violet light in the usual manner. The exposure is somewhat longer than the ordinary exposure, for we can of course only use visible light, and of this a part is stopped by the taking screen. The ordinary backs may be used. The displacement of the sensitive film from accurate register with the ground glass camera screen, owing to the presence of the taking screen in front of it, may be corrected (if thought necessary) by simply reversing the surface of the ground glass camera screen, turning the muffled side outward. This secures that the image will be accurately focussed in the plane of the sensitive surface. Negatives and positives may be used as ordinary negatives or positives till it is desired to recall the original colours. Thus, for those who wander with the camera, the possession of but the one seeing screen to test results is sufficient, and of course the one taking screen suffices to take an indefinite number of plates.

These considerations lead us naturally to observe that the registration of colour being really carried in the silver image, which with very little care in manipulation may be made permanent, secures that the colours are permanent. A faded screen may at any time be made good by a fresh screen; the colours in all cases being spectroscopically chosen, we are assured of the reproduction of the original colour. In this aspect the necessity of the detached colour screen is no disadvantage, but rather a necessary safeguard against the inevitable fading attending most pigment colours.

COMET MAGNITUDES.

Dr. Holetschek, of the Vienna Observatory, has recently communicated to the Imperial Academy of Sciences a paper on the magnitude and brilliancy of comets and their tails, with the view of arranging them in "magnitudes" or orders of brilliancy in a manner similar to that in which stars are arranged according to their lucidity. Further, from the data given as to the apparent length of the tail, the true length of the tail has been computed, and an inquiry instituted as to the possibility of tail formation and its probable length, based on the resulting magnitude of the comet and its perihelion distance.

If it be true that the brilliancy of a comet varies as the squares of the distances from the sun (r), and from the earth (Δ), then from observations made at various points of the orbit, the same "magnitude" ought to result for the values $r = \Delta = 1$. This magnitude Dr. Holetschek has deduced, where sufficient data existed, and the results can be practically arranged in two classes: one, in which the deduced magnitudes derived from various values of r and Δ so nearly agree that a mean can be taken; the other, in which is shown a regular progress, and always in the direction that the deduced magnitudes with small radii vectures, therefore when the comet is near perihelion, are greater than when at large distances from the sun. The origin of this is due to the fact that the second power of the radius vector does not fully represent the variations occurring in comets as they approach the sun, at which time their brilliancy is more increased than is shown by the ratio $1 : r^2\Delta^2$. The first case, it is suggested, is only a special case of the second, arising through insufficiency of description. This is most clearly shown when the time covered by the observations is short, or the details so wanting in accuracy that the deviation from the ratio $1 : r^2\Delta^2$ cannot be known with certainty. The conclusion drawn is that the formula so generally used can represent the brilliancy of a comet at different distances from the sun for a short time only, and is inapplicable for long periods.

Dr. Holetschek uses the deduced magnitude in the neighbourhood of the perihelion, valuable as showing the greatest brilliancy attainable in a particular comet, as the data for forming the comets into orders of magnitude, and inquires how far the tail formation is connected with this magnitude and the perihelion distance. He decides from his material, that when the deduced magnitude is 6 or lower than 6, only a short and feeble tail, or one not visible to the naked eye, is possible. Comets with a deduced magnitude of 4, or still brighter, have a tail well visible, which is the greater, the smaller the perihelion distance, and the smaller, the greater this distance. Within the limits between 4 and 5 magnitude, if we exclude very great perihelion distances, lie the possibilities of a considerable tail development.

Dr. Holetschek has also considered the diameters of comets, and sought to introduce order by reducing the apparent diameter to that corresponding to a distance of the comet from the earth equal to unity. In the case of Halley's comet, no diminution or variability is to be detected in either its brilliancy or the length of its tail. The same values serve from 1456 to 1835. As, however, on account of the continual development of the tail, a diminution of the mass is probable, it cannot be decided whether the approximate constancy, shown in the investigation, arises from inadequacy in the observations themselves, or is produced by certain processes existing in cometary bodies.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The delegates of the Common University Fund have elected Mr. Edwin Stephen Goodrich, Merton College, to the Biological Scholarship at Naples for the year 1895-96.

Cambridge.—The report to the Senate of the Engineering Laboratory Syndicate, dated November 9, 1895, is a very satisfactory record of energetic work. The University was unable to provide more than £1000 for the building and equipment of the laboratory, which was estimated to cost about £6000. By steady and enthusiastic efforts Prof. Ewing and his colleagues succeeded in collecting from many sources, within and without the University, the £5000 that were needed; and what is still more to their credit, have completed the work in hand with a small balance to the good. The continued growth of the department, in which there are now eighty-five students under instruction, makes a further extension of the buildings urgently necessary. A site has been provided for the purpose, but further funds are needed for construction. The workshops, never intended to be other than temporary, must soon be rebuilt, and more lecture-room accommodation must be provided. The department has certainly justified its existence, and the Syndicate have proved themselves to be worthy stewards of the funds placed at their disposal. It is to be hoped that, with these guarantees that they will be well used, the needful moneys may ere long be forthcoming. The valuable services of Mr. Dalby and Mr. Lamb, the demonstrators of mechanism and engineering, in the work of organising the laboratory, are mentioned with cordial appreciation in the report. Among the donors of contributions of over £100 are the Duke of Devonshire, the late Earl of Derby, Mr. Frank McClean, and Dr. John Hopkinson, and eleven benefactors have given £100 each. Valuable donations of apparatus and of books have helped greatly towards the furnishing of the laboratory.

The amount, clear of all expenses, available for the Robertson Smith memorial, is £1450. It has been agreed by the subscribers that sufficient of this amount should be invested to produce an annual income of £30, such income to be employed on the continuance and extension of Prof. Robertson Smith's library, which he bequeathed to Christ's College. It was also resolved that the remainder of the amount collected, after all expenses have been paid, be handed over to the University for the purchase of Oriental MSS. for the University Library, which shall be marked as having been acquired by means of the fund. It is estimated that about £300 will be handed over to the Syndics of the Library.

It is reported that Mr. P. N. Russell has given the sum of £50,000 to endow a school of engineering in connection with the Sydney University.

An address on the present state and position of technical instruction in this country, delivered by Major-General Sir John Donnelly before the Society of Arts on Wednesday, November 20, is printed in full in the current *Journal* of the Society.

The annual meeting of the National Association for the Promotion of Technical and Secondary Education, and the Conference of Representatives of Technical Education Committees, will be held on Tuesday, December 10, at the Royal United Service Institution, Whitehall.

THE following announcements are made in the *Johns Hopkins University Circular* (No. 121):—Sir Archibald Geikie has accepted the invitation of the President and Board of Trustees of the Johns Hopkins University to inaugurate the George Huntington Williams Memorial Lectureship, and has selected October, 1896, as the time for delivering his lectures.—Prof. Cleveland Abbe, of the United States Weather Bureau, will, during January next, give four lectures upon Climatology in its relations to Physiography.—Mr. G. K. Gilbert, of the U.S. Geological Survey, will begin a course of lectures upon Physiographic Geology the second week in January, and will lecture four times weekly until about the end of February.—Mr. Bailey Willis, of the U.S. Geological Survey, will commence his lectures upon Stratigraphic and Structural Geology, as soon as Mr. Gilbert has completed his course, and wlll lecture twice weekly until the middle of May.—Dr. R. M. Bagg has been appointed assistant in Geology.

SIR JOHN GORST, in a speech delivered last Thursday at the annual meeting of the London Society for the Extension of University Teaching, remarked that "though they were all anxious that the scientific education of the country should be fully developed, it would be a great mistake if that development were to take place at the expense of the literary side of education. A proper liberal education is fairly balanced on all sides, and no system which extends one branch of education at the expense of others can be productive of anything in the long run but mischief." Just so. We have always urged that science should receive as large a share of attention as literature in our colleges and universities; but no one can say that it does. Some of Sir John Gorst's hearers took his remarks to indicate a reaction against the increased facilities now being offered for instruction in science; but if the remarks are taken literally, they mean that scientific education should be fostered, and placed upon the same footing as the humanities.

SCIENTIFIC SERIALS.

American Meteorological Journal, November.—Relations of the Weather Bureau to the science and industry of the country, by Prof. W. L. Moore, Chief of the Weather Bureau. It is satisfactory to find that the change of Chief will not affect the scientific activity of the U.S. Weather Office, as many people supposed. Prof. Moore quotes the Act of Congress of October 1, 1890, which prescribes the duties of the Chief, from which it is seen that the main object of the Bureau is to give warning of the approach of storms, and therefore that the proper line of investigation should be relative to their mechanism. Systematic exploration of the upper air, with a continuation of the studies of terrestrial magnetic forces, begun by Prof. Bigelow, will be the line of investigation prosecuted during the next two years. With regard to estimating the probability or severity of frost, Prof. Moore thinks that sufficient weight has not yet been given to the dryness or wetness of the soil, and he calls for special attention to this point —The meteorological observatory on Monte Cimone, Italy, by A. L. Rotch. Monte Cimone is the culminating point of the Northern Apennines, attaining a height of 7100 feet above the sea, and it is the only summit station in Italy, the observatories of Vesuvius and Etna being both situated on the flanks of these volcanoes. Both the summit and base stations are provided with self-recording instruments, and are dependent upon the Central Meteorological Office at Rome, with which there is telegraphic communication.—Physiological effects of high altitudes, by A. L. Rotch. The author points out the importance of the effect of the rarefaction of the air on the human system, which is, as yet, but imperfectly understood, and refers to his own experiences at great heights in the Alps and Andes.

Wiedemann's Annalen der Physik und Chemie, No. 10.—The practical use of Wheatstone's bridge, by F. Kohlrausch. The meter bridge is greatly improved and made more sensitive by introducing two resistances, 4·5 times the resistance of the wire, at one or both ends of it. The wire may also be rolled on a roller of marble or wood boiled in paraffin, with a flat spiral groove. With an enlarged scale reading to thousandths the author claims to have attained a limit of error of 1 in 25,000.—Density measurements of extremely dilute solutions, by the same author. These were made, as before, by weighing a glass sphere immersed in the liquid. But as the sphere used was heavier in this case, the cocoon fibre suspending it had to be replaced by a fine wire of dull platinum. The accuracy was then carried to the seventh decimal place, the only limit being the accuracy of temperature measurements.—Luminescence of solids and solid solutions, by E. Wiedemann and G. C. Schmidt. This is a continuation of previous researches on photo-luminescence and cathodo-luminescence, or the phosphorescence produced by the impact of light and cathode rays respectively on certain bodies, such as sulphates. A list of the most brilliantly luminescent substances is given, including "solid solutions," in van 't Hoff's sense, of $MnSO_4$ in other sulphates. The kind of luminescence of the latter depends only little upon the concentration, but much upon the kind of solvent. The lower the temperature the brighter the light. But the sulphates of copper, iron, and nickel extinguish it altogether, even in small quantities. The spectrum of the rays emitted is in every case a continuous spectrum consisting of one band.—On the absorption of cathode rays, by P. Lenard. The ratio between the absorptive power and the density is the same for all media, whatever their state of aggregation, provided the cathode rays are of the same kind.—Cathode rays and continuous discharges in gases, by O. Lehmann. This paper deals with the question of the actual nature of gas discharges.—The cooling effects of air currents, by A. Oberbeck. These are measured by finding what velocity of air is required to prevent the glowing of a platinum wire conveying a current. It is proposed to use this as a sensitive anemometer.—Anomalous dispersion curves, by A. Pflüger. Cyanine and Hofmann's violet have refractive indices below 1 for rays between F and G, and fuchsine, magdala red, and malachite green all show an increase of refrangibility with increase of wave-length in certain portions of the spectrum.

Bulletin de la Société des Naturalistes de Moscou, 1894, Nos. 3 and 4.—On the Ostracodes fauna of the neighbourhoods of Moscow, by A. Croneberg (in German). Twenty-three species are described, of which *Cyclocypris pygmæa* and *Erpetocypris peregrina* are new (with plates).—On the slates of Megalo-Aialo, near Balaklava, by D. P. Stremoukhoff (Russian, summed up in French). The presence of a number of Amonites, characteristic of the Bath and Kelloway strata, settles their age.—The birds of the government of Moscow, by Th. Lorenz. A list (in French) continued from a previous number.—The development of the tarsus in *Pelobatus fuscus*, by M. Chomiakoff (in German).—Two new Aphides from South Russia (*Stomaphis Graffii* and *St. macrohyncha*), by N. Cholodkovsky (in German) The microscopical structure of the electrical organ of the torpedo, by N. Iwanzoff, a large detailed work (in German), with plates in both numbers.—Yearly report of the Society.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 22.—Special meeting.—Captain W. de W. Abney, President, in the chair.—The following resolution, with reference to the articles of association, was passed. In Article 33, to strike out the words "by the payment of £10 in one sum," and in place of this to insert the words "the composition fee shall be, for every member who shall not have paid ten annual subscriptions, fifteen times the amount of the annual subscription payable by such member, and for any member who shall have already paid ten or more annual subscriptions, ten times the amount of the annual subscription payable by such member."—The ordinary meeting then took place.—Dr. G. Johnstone Stoney exhibited a print of Profs. Runge and Paschen's photograph of the spectrum of the gas obtained from clevite, together with a diagram illustrating the manner in which these observers have arranged *all* the lines obtained in two sets, each set containing three series of lines. Dr. Stoney also drew attention to the resemblance between each of these sets of three series of lines and the similar triple series obtained in the case of the metals of Mendelejeff's first group. The lines of the different series in the case of the gas obtained from cleveite have certain definite peculiarities which permit of their identification and selection. The two gases, to the presence of which the two sets of lines are presumably due, can be partly separated by diffusion through a plug of asbestos. Prof. Ramsay's observation that by suitably altering the pressure of the gas the predominance of the lines in either of the two sets can be increased is, however, against the

theory that the two gases are really separated by diffusion. Three of the original negatives taken by Prof. Rowland when preparing his map of the solar spectrum were also exhibited. Dr. Gladstone said he had examined the spectrum of the gas in two tubes, one of which had been filled by diffusion through an asbestos plug, and the helium line (D_3) was certainly brighter in one tube than in the other, though the brightness of the remaining lines appeared about the same in both tubes. As to the difficulty of allocating the new gases in Mendelejeff's table, it appeared to him (Dr. Gladstone) that they would have to be put in the first group between hydrogen and lithium. An examination of the successive differences between the atomic weights of ad jacent members of the metals in the first group showed that these differences increased as we go downwards. If then the new gases have atomic weights of, say, 2 and 4, we should have for these differences 2, 2, 3, 16, 16, 26, &c., instead of 6, 16, 16, &c., as at present. The important point which required investigation was whether these two gases were really simple bodies or not. Prof. Silvanus Thompson asked if Runge and Paschen had performed a similar analysis of the lines in the spectra of other elements besides the members of the first group. He would also like to know if in the case of any element besides hydrogen the lines could be arranged in a single series. Dr. Stoney, in reply, said that the spectra of most of the metals had been analysed, the chief exceptions being iron, nickel, cobalt, and manganese. There was no other element besides hydrogen which gave a single series of lines. Prof. Herschel gave an account of a line of reasoning which had led him many years ago to a formula resembling that expressing Balmer's law for the hydrogen lines, namely, $\frac{1}{\lambda} = 1 - \frac{4}{n_2}$. The Chairman (Captain Abney) drew attention to the fact that Runge expressed his result to 1/1000th of an Angström unit, although Dr. Stoney had said the measurements could only be made to within 1/50th of a unit. There was great lack of uniformity in the method of drawing spectra in general use; he strongly recommended the placing of the red end of the spectrum to the right, so that the wave-lengths increased from left to right. As to the three series of lines obtained in the case of most elements, it was not conclusively proved that they were not due in each case to three distinct kinds of molecules, and it will probably be found that there are more than two simple gases present in the gas evolved from cleveite.—Mr. R. Appleyard read a note on the action of sulphur vapour on copper. When a copper wire is exposed for some time to the action of sulphur vapour, it becomes entirely converted into sulphide of copper, and it is found that there is a fine axial hole running down the rod of sulphide formed. Rods of copper of square section cut from a block of copper after exposure to the action of sulphur vapour also exhibited the axial hole, the rod of sulphide formed being of circular cross-section. In every case the diameter of the rod of sulphide is about twice that of the original rod of copper. Delta metal was found to be unacted upon by the sulphur vapour.—Mr. Appleyard then read a paper on a "direct-reading" platinum thermometer. This form of platinum thermometer has been devised with the view of determining the temperature of the dielectrics employed in some experiments on the variation of the electrical resistance of dielectrics with temperature. The thermometers consist of six platinum coils, each of about seven ohms resistance, attached to thick copper leads. A slide-wire Wheatstone's bridge is employed to measure the resistance. The stretched wire is three metres long, and the moving contact so arranged that it is impossible to damage the wire. The auxiliary coils used in connection with the bridge are immersed in a bath of paraffin oil, the temperature of which is maintained constant, and a little above that of the air, by means of a glow-lamp immersed in the oil. Mr. Appleyard also read a historical note on resistance and its change with temperature, in which he showed that the earliest measurements of the variation of resistance with temperature were made by Lentz in 1833. Some experiments on this subject made by Davy were also referred to, and some of these experiments repeated before the Society. Mr. Trotter said he agreed with the author, that the "reserve of precision" at our disposal, on account of the delicacy of some of the modern instruments, ought to be made use of to facilitate the rapid performance of many measurements where the utmost accuracy is not necessary. He had the impression that platinum silver was not now considered the best material for use as the bridge wire. Mr. H. F. Burstall explained the differences between the temperature as measured on the mercury, air and platinum thermometers. At a temperature of about 40° the platinum thermometer read about 0°·4, and the mercury thermometer about 0°·1 below the air thermometer. Prof. Callendar had obtained measurements of temperature correct to within 0°·1 by using a Weston voltmeter and an ordinary Wheatstone bridge the variations of resistance, and hence the temperature being read directly from the deflections on the voltmeter. Mr. Rhodes thought that, except where extreme accuracy was necessary, the mercury thermometer was very much more convenient than the platinum thermometer. Mr. Burstall said the great convenience of the platinum thermometer lay in the fact that the scale could be read at a distance of many yards from the point where the temperature was being measured, and hence could be used in many places where it would be impossible to read a mercury thermometer. Mr. Blakesley considered that the author was somewhat bold to state that for general purposes it was never necessary to measure temperature to nearer than one-tenth of a degree. The author having replied, the Society adjourned till December 13.

Mathematical Society, November 14.—Major MacMahon, R.A., F.R.S., President, in the chair.—The President announced the death of Mr. E. H. Rhodes (elected June 10, 1875), which took place on the 1st inst —The gentlemen, whose names were published in NATURE of October 31, were, after the ballot had been taken, declared duly elected on the Council for the ensuing session.—The President stated the reasons which had led Mr. M. Jenkins, after thirty years' tenure of the office, to resign his position of Secretary, and moved a vote of thanks to that gentleman for his "devoted services of thirty years" to the Society, and coupled with the vote the hope that his health might be improved by his retirement to the country. The vote was seconded by Mr. Kempe, F.R.S., and supported by Mr. S. Roberts, F.R.S., who had been connected with the Society almost from its inception. After the vote had been unanimously carried, Mr. Jenkins suitably thanked the Society and the speakers for their good wishes and appreciation of his services. The following papers were read or communicated: On the stability and instability of certain fluid motions (iii.), and on the propagation of waves upon the plane surface separating two portions of fluid of different vorticities, by Lord Rayleigh, Sec. R.S. The two earlier papers upon the subject of these communications are to be found in the Society's *Proceedings* (vol. xi., 1880, and vol. xix., 1887).—Determination of the volumes of certain species of tetrahedron without employment of the method of limits, by Prof. M. J. M. Hill, F.R.S. Proofs are first given of the propositions: (A) that it can be shown without dissection that symmetrically equal tetrahedra are equal in volume. (B) That two tetrahedra having a common base, and being the images of one another with regard to that base, are equal. (C) That a tetrahedron, in which the line joining the middle points of two opposite edges is perpendicular to those edges, can be bisected into two superposable tetrahedra by a plane through either of these edges and the middle point of the other. By means of (B) a tetrahedron of special form is constructed, such that a prism can be built up of this tetrahedron and two of its successive images. The volume of this species of tetrahedron is then known without employment of the method of limits. Calling it ABCD, its sides are expressible in terms of two parameters a, r as follows:

$$AC = a\sqrt{9 - 3r^2}, \quad AD = BC = 2a,$$
$$AB = BD = DC = a\sqrt{1 + r^2}.$$

By means of (C) two other types of tetrahedra, whose sides are expressible in terms of two parameters, are deduced from the tetrahedron ABCD. Also by a consideration of a special case of the tetrahedron ABCD, the volumes of two tetrahedra of definite shape, not included in the above-mentioned types, are determined.—An extension of Sylvester's constructive theory of partitions, by the President. In connection with this paper the President communicated a paper by Prof. Forsyth, F.R.S., entitled, "Some algebraic theorems connected with the theory of partitions.' The paper is concerned with a general method leading to the proof of some theorems required in Major MacMahon's investigations in the partitions of numbers. They depend upon the summation of terms selected from the series, which is the expansion of particular fractions, and the summation is effected algebraically.—On the evaluation of a certain dialytic determinant, by Mr. W. W. Taylor. In a paper read before the Society in March 1894, Prof. Elliott (the author) remarked: "It

is unfortunate for the simplicity of the argument of this paper that the property of such a determinant as Δ, that after division by its obvious factors $F(\rho, 1)$, $F(\rho, -1)$, it leaves a perfect square, is one which, as far as I know, direct algebraical methods have not yet supplied." This *lacuna* Mr. Taylor supplies.—Lieut.-Colonel Cunningham, R.E., communicated a criterion of 2 as a 16^{ic} residue, and added some remarks upon certain of Mersenne's numbers.—The following papers were taken as read: Notes on matrices, by Mr. J. Brill; certain general series, by Mr. F. H. Jackson; note on the representation of a conic by a linear equation, by Mr. J. Griffiths; on the representation of a number as a sum of two squares, by Prof. G. B. Mathews; researches in the calculus of variations: part vii., limiting conditions in multiple integrals; part viii., reduction of the problem of the discrimination of maxima and minima values in double integrals with variable limits to a new problem in single integrals, by Mr. E. P. Culverwell; a note on certain forms of the equation of normals to conic sections, by Mr. J. L. S. Hatton.

PARIS.

Academy of Sciences, November 18.—M. Marey in the chair.—Truffles (*Terfezia hanotauxii*) from Teheran, by M. Ad. Chatin. The characteristics of Persian truffles and their spores are described. The name *Terfezia hanotauxii* is given to these truffles as forming a new species. The most important characters are given for comparison of the other known species of Terfezia: *T. claveryi*, *T. boudieri*, *T. hafizi*, and *T. leonis*.—On a probably new element existing in the terbium earths, by M. Lecoq de Boisbaudran. The evidence relied upon is that of an absorption band at λ 487·7, which the author fails to connect with known elements.—A memoir, by M. A. Sarrat, on a demonstration of Fermat's theorem. Impossibility of the equation $a^n + b^n = c^n$ in whole numbers, was submitted to a committee.—A note of M. J. Laborde on the causes of the formation of hail was similarly disposed of.—Observations of the sun, made at Lyons Observatory (with the Brunner equatorial) during the second quarter of 1895, by M. J. Guillaume.—On the employment of punching and shearing as methods of testing metals, by MM. L. Bacte and Ch. Fremont. A machine, called by the authors an *elasticimètre*, is described by means of which indicator diagrams are obtained which show the actual character of the instantaneous stresses developed in the operations of punching and shearing. Special test-samples are not required, the machine is applied while the material is being worked up in the ordinary way.—On a power dynamometer specially applicable to physiological studies, by M. Charles Henry.—On the origin of atmospheric oxygen, by M. T. L. Phipson. The author recalls the results of his researches on this subject, and summarises them as follows: (1) In the most distant geological periods nitrogen formed, as now, the principal part of the earth's atmosphere. (2) The presence of free oxygen in this atmosphere is entirely due to vegetation. Primitive plants were the means by which oxygen was naturally supplied to the air. (3) Plants now living are, like those of geological times, essentially anærobic. (4) As the quantity of free oxygen in the atmosphere has gradually augmented, the anærobic cell has become modified into more or less ærobic forms (fungi, bacteria), and finally has become completely ærobic (in animal life). (5) The lowest unicellular algæ give, weight for weight, much more oxygen to the atmosphere than to the superior plants. (6) In proportion with the slow increase of the relative quantity of oxygen in the air, the cerebro-spinal nervous system, the highest characteristic of animal life, has become more and more complex.—Synthesis of methyleugenol. Constitution of eugenol, by M. Ch. Moureu. Allyl veratrol is synthetically formed and shown to be methyleugenol. It follows that eugenol is an allylguaiacol.—On the cholesterines of the cryptogams, by M. E. Gérard.—On the distribution of pectase in the vegetable kingdom and on the preparation of this diastaste, by MM. G. Bertrand and A. Mallèvre. Pectase may be regarded as of universal occurrence in the green plants. It is especially abundant in leaves, and probably spreads from the leaves to the other organs. The richness of certain leaves in pectase has permitted the preparation of this ferment.—Researches on the Tapidæ, by M. Piéri.—Study on the reproduction of wasps, by M. Paul Marchal.—On a morphological modification of species and on the heredity of acquired characters, by M. Rémy Saint-Loup.—On a disease of the sloe-tree contracted spontaneously by a maple, by M. Paul Vuillemin.—On the structure and optical properties of divers compact or earthy silicates, by M. A. Lacroix. The minerals studied, though apparently compact and earthy, are formed wholly or in part of a crystallised substance having many of the properties of mica.—On the optical isomorphism of felspars, by M. Fr. Wallerant.—Triassic ammonites from New Caledonia, by M. Edmond de Mojsisovics.—On the retting of flax and the microbe concerned, by M. S. Winogradsky.—On the use of viper's and adder's blood as antivenomous substances, by MM. C. Phisalix and G. Bertrand.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Manual of Physics: Dr. W. Peddie, 2nd edition (Baillière).—Thirteenth Annual Report of the Fishery Board for Scotland. Part 3. Scientific Investigations (Edinburgh, Neill).—Mechanics, Hydrostatics: R. T. Glazebrook (Cambridge University Press).—Cambridge Natural History. Vol. v. Peripatus, Myriapods, Insects: A. Sedgwick, F. G. Sinclair, and D. Sharp (Macmillan).—Molecules and the Molecular Theory of Matter: A. D. Risteen (Ginn, Boston).—On the Densities of Oxygen and Hydrogen, and on the Ratio of their Atomic Weights: Dr. E. W. Morley (Washington).—Elementary Inorganic Chemistry: Prof. A. H. Sexton, 4th edition (Blackie).—Earth-Knowledge: W. J. Harrison and H. R. Wakefield, Part 1, 9th edition (Blackie).—Food and its Functions: F. Knight (Blackie).—Minerals and how to Study them: E. S. Dana (Chapman).—Grundgesetze der Molekularphysik: T. H. Schwartze (Leipzig, Weber).—Sur l'Origine du Monde: H. Faye, troisième édition (Paris, Gauthier-Villars).—Essais sur la Philosophie des Sciences. Analyse-Mécanique: C. de Freycinet (Paris, Gauthier-Villars).—First Stage Mechanics: F. Rosenberg (Clive).—Observaciones de Precision con el Sextante, Conde de Cañete del Pinar (Madrid, R. Alvarez).—The Wild Fowl and Sea Fowl of Great Britain: A Son of the Marshes (Chapman).

PAMPHLETS.—Cantor Lectures on Commercial Fibres: Dr. D. Morris (Trounce).—An Account of the Smithsonian Institution (Washington).—The Exhibit of the Smithsonian Institution at the Cotton States Exposition, Atalanta, 1895 (Washington).—Christian Huygens: J. Bosscha (Leipzig, Engelmann).—The Common Crow of the United States: W. B. Barrows and E. A. Schwarz (Washington).

SERIALS.—Natural Science, December (Rait).—Longman's Magazine December (Longmans).

CONTENTS.

THURSDAY DECEMBER 5, 1895.

THE ORGANISATION OF SCIENCE.

As we are accustomed in this country to look on the *Times* as a political barometer, the appearance in it of the very admirable article to which we drew attention last week must be regarded as proof that the exigency of the situation in which the nation is placed is likely soon to attract some share of the attention it imperatively demands. And the question arises how we may best secure that "scientific organisation in the field, in the workshop, in the laboratory, and in the conduct of national policy" which the *Times* so fully and justly recognises to be essential to our national safety.

It is just twenty years since the Royal Commission on Scientific Instruction and the Advancement of Science, presided over by the Duke of Devonshire—father of the present Duke—issued their final report in which they emphatically recommended the appointment of a Ministry and Council of Science. The report is full of evidence of a most convincing character, given by witnesses of the greatest eminence and wide experience; and when we recollect that it was signed by such men as the late Duke of Devonshire, Lord Lansdowne, Huxley, Sharpey, Henry Smith, Stokes, Bernhard Samuelson and Lubbock, it is more than surprising that its provisions should have been so completely neglected. In point of fact, and most unfortunately, nothing has yet been done to bring the State thoroughly into touch with science, and to lead it to regularly avail itself on all possible occasions of the services of qualified scientific advisers.

Had such a Council been called into existence, it would undoubtedly have operated in two ways. In the first place, its members would inevitably have had their attention drawn to public affairs, and the narrowness of purview which too often characterises the work and thoughts of men devoted to science, as well as of business men, would have given place to broad conceptions of civil duty, so that an ever-widening influence would have been secured to them. On the other hand, by gradually bringing about the introduction of scientific methods of regarding and treating State problems, they would have conferred inestimable service on the nation, and the growth of a system of rational statesmanship would have been encouraged. We are indeed able to form an effective estimate of what might have been the result of their labours—for, having commenced to organise our public service at about the same time, and pursued similar methods, we should not improbably have attained to a position comparable with that in which the Japanese appear now to be placed.

It would certainly have been impossible for the minister at the head of our educational affairs to gravely argue in 1895 in favour of granting to a small group of irresponsible individuals a post-card veto on the finding of a Statutory Commission, which his Government are begged to appoint to finally adjust the claims of the various parties concerned in the foundation of a University in London. Nay more, our minister would have been in a position to say that sheer force of circumstances compelled him to recognise that it was of the utmost national importance to immediately secure the effective organisation of all the higher educational interests of the capital of the empire—indeed, our Government would long since, at the instigation of its scientific council, have taken the matter into its own hands, and have brought about such organisation, instead of requiring to be positively compelled to act.

The existence of such a national council of scientific advisers—the words are used intentionally, as we are thinking of a council of men scientifically trained and of proved ability and originality—would infallibly have exercised a most potent influence on public opinion: in forming it and educating it. It would have spread abroad the spirit of inquiry by making it operative in every branch of the public service. The manufacture of red-tape would have fallen into oblivion instead of that of aniline dyes; agriculture would have been cared for, as it would have been foreseen that the lowering of freights, consequent on improvements in shipbuilding and the introduction of steam, made it necessary to relinquish wheat-growing into the hands of those who can command cheap labour and constant sunshine; and probably we should have learnt to make butter and grow onions at home.

Each of our public departments would have had a scientific staff, charged not merely with the duty of carrying out its routine work, but also expected to contribute to the growth of scientific knowledge, in order both to maintain touch with the outside world, and preserve and extend their interest in the subjects with which they were concerned. Only those can institute progress who themselves progress, and it is clear that this was fully recognised to be the case by the Duke of Devonshire's Commission, as it is stated in so many words in the report, that there was a general concurrence of opinion that, even in the interests of the Government Departments themselves, more ought to be done by the Government in the way of investigation.

The condition of our public service in these respects is nothing less than deplorable, and yet, when the example set by Kew—which, during many years past, has always been in the hands of highly-qualified scientific administrators—is taken into account, the advantages to be derived are so obvious. Where are the scientific men connected with our great departments of national defence in evidence? Most important researches on explosives have issued from Woolwich in days gone by; and Froude's great work under the Admiralty was epoch-making. What is being done at the schools where naval and military officers are being trained to make an atmosphere of research not only possible but essential? And when we pass to our colossal Indian empire, what is being done there to encourage the growth of the scientific spirit among those concerned in the administration of its affairs? We believe that at the present moment there is but a single agricultural expert available for the whole of India, and yet agriculture is the one industry on which the country is practically dependent. Why is engineering considered to be the only branch of science worthy of introduction into the public service?

As the present President of the British Association

said in his evidence to the Duke of Devonshire's Commission, "Our statesmen do not appreciate properly the value of scientific advice or scientific inquiry, and they are very much fonder of experiments made upon a large scale with no defined system, than they are of experiments which have been brought out as the result of a carefully studied previous inquiry." This is as true now as it was twenty years ago, and probably many hundreds of millions which might have been gained have been sacrificed in consequence.

The *Times* pointed out last week that, on his first appearance as Member for Foreign Affairs, M. Berthelot asked for money for the establishment of six new consulates in China. M. Berthelot may be properly described as the most original living chemist; he is certainly also the most prolific in ideas. As his Government will probably soon be thrown out in the natural course of affairs French, it might be well for us to consider whether a man who is capable of conceiving so daring an idea immediately on entering into political office might not—although a member of a class considered incapable of governing in this country—be invited over here to leaven our public service.

Reflections such as these should, however, give food for thought, not only to men of affairs, but also to those who are engaged in scientific work, and should lead the latter to ask themselves whether they are doing their duty in all respects—and this is especially the case at a time when we are seeking to appraise the value of Huxley's labours. Important as was his scientific work, and much as we are disposed to agree with Mr. Balfour as to the inestimable public service he rendered in making the doctrine of evolution plain and popular, the work he did in displaying the meaning of scientific method to people generally was, if possible, of even greater value. Yet how few follow his example—how few are prepared to be unselfish and to withdraw themselves from the fascination of their private investigations to labour in the cause which Huxley and also Kingsley made holy. If more had followed their example, we should now have far less cause to deplore the failure to apply scientific method in the public service which has led to the present break-down.

THE GROWTH OF THE BRAIN.

The Growth of the Brain. A Study of the Nervous System in Relation to Education. By H. H. Donaldson, Professor of Neurology in the University of Chicago. "Contemporary Science Series." (London: Walter Scott, 1895.)

THE "populariser" of science (who differs widely in kind from a Helmholtz or a Tyndall—the writers of popular science) labours under great disadvantages. He is compelled to give a scissors-and-paste account of the work done by other people in different departments, and to summarise a number of perfectly distinct monographs, omitting all the experimental evidence which alone gives value to the conclusions. He must not express any original criticism, and he usually has to bring in a moral. To say the best of it, he writes about science with an object, whereas science must be trodden for itself, like a Swiss mountain. It is a little sad to think that neurology is going to have an object—judging from the essay before us. It will become the lumber-room for histological details, weight statistics, architectural dimensions, a little physiology—very little—and some educational cobwebs to weave them all together. But such a collection should at least be up to date at the time it is offered to the public. An account of "localisation of cerebral function," with no reference to Munk and Goltz, no suggestion that opinions differ as to the extent of localisation, or that the expression "sensory *vs* motor" (tracts), has previously been termed "misleading," no hint that in the absence of the higher centres, function may be taken on by the lower, in any less long-suffering animal than the "brainless frog," does not lead one to anticipate much neurological pabulum.

The account of nutrition, again, is very inadequate; cell diffusion is referred to in almost purely mechanical terms, with little reference to the physiological activity of the epithelium. "Thyroid feeding," too, is casually introduced in a foot-note, with a couple of references to medical journals. Yet Brown-Séquard's name is not unknown, and we have lately heard a good deal about "internal secretion." Nor is the account of metabolism in the nerve-fibre very satisfactory. We are told that "it is possible to assume that there are metabolic changes which have not yet been detected, *or* that the nerve impulse is not accompanied by such changes." And again: "Physiologists have been busy at the same time seeking to determine how far the passage of a nerve impulse along a fibre causes fatigue-changes in it"; (no conclusion given).

Another loose statement is to the effect that the beat of the heart is an example of the automaticity of the nervous system. How then does it come about that rhythmic contractility appears in the embryonic heart before the nervous system has been developed?

Weismann has been assimilated, and is written out large for the "growth period of races and nations": so that, as Prof. Donaldson says, "the germ-plasm wears the appearance of immortality."

But we look in vain for any reference to recent French studies in experimental psychology, in which there is a fund of suggestion for "the parent, the teacher, and the physician," who are to "seek light" from the "facts within these covers." The question of types of perception—and of memory—is one of the most interesting in modern educational psychology. Instances are being classified every day of the visual, or auditive, or motor temperament; and surely we all know which is the particular language of our own translation of experience? Yet Prof. Donaldson can only suggest that "it is now recognised that thought can be carried on in terms of the several senses. In this connection Fraser (*Am. J. of Psychol.*, 1892) has made an examination of certain philosophic writers, which indicate that particular writers, or schools, prefer sense-images of one mode in their speculative thought, and he suggests that much of the failure to be mutually comprehensible depends on the fact that tactual and visual images, for example, are by no means capable of being manipulated in the same manner, and hence that relations conceivable in the terms of one are often not so in those of the other. With the employment of one sort of mental image comes precision; but it is precision gained at the price of limitations Fortunately

the law of the diffusion of incoming impulses works against a too great specialisation in this direction. Yet in the highly defective this specialisation must be carried very far, and in those whose endowments are distinctly unusual the dominance of one sense in controlling the reactions of the central system may rise to *the dignity of a deformity*." The last words should bring comfort to any poor victim of a temperament, but are a cheap substitute for the clear thought and scientific terminology of M. Binet or M. Ribot.

The account of consciousness and the relations between stimulation and sensation is also very defective. "Granting," we are told, "that the central system responds throughout a large extent to all the impulses acting upon it, and that by virtue of these responses the background varies; it remains to be determined how far the law and order in these changes can be formulated. . . . The reactions obtainable by the application of a given stimulus depend on the other stimuli with which the new one is competing. Cold water does not feel cold after ice; a black line on a grey surface has a value different from the same line on a white one, and so on throughout all contrasts. This relation between the stimulus and the sensation is expressed in the psycho-physic law by the formula that sensation increases in intensity according to the logarithm of the stimulus. The limits within which this law is applicable do not immediately concern us, its use here being purely to express the fact that at any moment the activities of the nervous system under the influence of existing stimuli *form a background against which a new stimulus, according to its intensity and character, may or may not be recognised*." (The italics are ours, here and elsewhere.)

The poverty of this conception of consciousness is typical of the whole book, which reads like a "background"—a dull record of facts with no living factors playing in and out of them, and making the physiological and psychological aspects into a conscious unity. It seems to have missed its mark, inasmuch as it is neither a scientific text-book nor a social philosophy.

F. A. WELBY.

THE VALLEY OF KASHMIR.

The Valley of Kashmir. By W. R. Lawrence, C.I.E. (Oxford: Frowde, 1895.)

UP till now the standard authority on Kashmir was Drew's well-known book. It contained a good deal of information about routes and passes, and concerned itself not so much with Kashmir proper as with the outlying and dependent territories. The present work has a more restricted aim, and deals more thoroughly with its subject. The reader must distinguish between Kashmir the kingdom and Kashmir the vale. The former is a large territory containing enormous mountain areas, chiefly uninhabited and stretching, in theory at any rate, from Tibet to Chitral and from the Pamirs to the border of the great Indian plain. But Kashmir proper is a level valley, apparently an old lake basin, included between a fork of the Himalayas. On the map it resembles, as Mr. Lawrence well remarks, a white foot-print set in a mass of black mountains. The level of the valley floor is about 6000 feet above the sea, and it is approximately 84 miles in length and 20 to 25 miles in width. Numerous trade-routes debouch upon this valley and concentrate upon its populous capital, Srinagar on the Jhelum. To Kashmir proper may also be reckoned the fertile lower portions of a number of tributary side-valleys, for the most part exceedingly beautiful, and well marked with wood, water, and meadow. This beautiful area—the garden of India—is shut off from the rest of the world by bare and, in many places, snowy mountain ranges, or by a gorge which has only a few years ago been trained to admit a cart road. It is inhabited by an interesting race, speaking a language and having a literature, a written history, and an art of their own. Thus Kashmir is marked out by nature, history, and circumstance as a geographical unit suited for separate treatment and study.

The Government of the Happy Valley was up till recently, in some respects, one of the worst in Asia. There was no security of property, and personal liberty hardly existed for the peasantry, who were liable to forced labour at any time of the year, however ruinous to their industry, and had to pay taxes to swindling publicans, equally disloyal to the tax-payer and to the State. To put an end to this state of things became a crying necessity. A survey and land-settlement was decreed, and entrusted to officials under British direction. The bulk of the work was done by Mr. Lawrence, who has been for some years the Maharaja's Settlement Commissioner, and by whom the whole transaction has been concluded. In his daily labour he has been brought in contact with all classes of the community, and especially with the peasants. He has been obliged to make himself familiar with the nature of soils, the systems of irrigation and agriculture, the character of the crops, the resources of the country generally, the system of taxation, the character of the official class concerned, and to deal with its collection, and all manner of similar and connected questions. In course of his work he has been forced to accumulate a large body of notes on these matters, and he was thus designated by circumstances as the man best suited to report on the condition and prospects of the country generally. I gather that the volume under consideration is practically the report, or the major portion of the report, drawn up by Mr. Lawrence for the Indian Government which placed his services at the disposal of the Kashmir Durbar.

The scheme of the report is drawn on large lines. There are chapters descriptive and historical. Others deal with the geology, physical history, flora, and fauna of the valley and its surrounding slopes. There is a chapter on archæology, another on statistics, whilst the remainder deal with the people, their races, languages, religions, manners and customs, industries, and trade, and with the old Administration and the new Settlement. Some of these chapters are admittedly compilations. That on geology is little more than a reprint of passages from Lyddeker's memoir. Less satisfactory is the archæological chapter, which chiefly consists of quotations from Sir Alexander Cunningham's reports—excellent at the time they were written, but now superseded by the work of excavation and research which is being done for the Indian Government by Dr. Stein. The chapter on the flora makes no profession of completeness, but, being contributed by experts, is authoritative as far as it goes. It is chiefly confined to "plants and trees possess-

ing some well-known economical value for the people." The fauna chapter is remarkable chiefly for its full list of the birds of Kashmir—a region very rich in birds—and here the author is able to introduce a number of original observations.

In the remainder of the book he writes as an authority of the first rank, and conveys a mass of new and admirably digested information. His contact with the people was evidently of a sympathetic character. The Kashmiri is usually not beloved by the European. His effeminate dress is against him, to start with. His moral and physical cowardice seem superlative. He appears to be fundamentally a liar and a cheat. Such, indeed, are too often the characteristics of the boatmen class with whom the traveller comes most in contact. But the Kashmiri *shikari* is of a finer sort, and many of them are well beheld by their employers. Mr. Lawrence explains that the truly typical Kashmiri peasant is really more of the latter type. He has vices, patent enough; but they are rather to be ascribed to the misgovernment, of which he has been victim for centuries, than to any original sin. The people are conscious of their degradation, and explain that it is the result of a curse from heaven, against which it is idle to protest. That curse Mr. Lawrence has done much to remove. In his quiet methodical fashion he has gone through the country with open eyes and healing hands. It is to be assumed that he went there to do a piece of work, and did it to the best of his ability, with no flaming ideals and high-sounding intentions. As a result, he has accomplished an amelioration in the lot of some hundreds of thousands of his fellow-creatures, great enough to warrant a less efficient founder of a new religion being raised to a pinnacle of eternal sanctity.

It is impossible within the limits of a brief review to give any idea of the volume and extent of work involved in the Settlement, and now actually accomplished. I was myself witness of some of its smaller fragments and effects. Still less can any idea be given of the value of the author's contributions to anthropology contained in this volume. He has entered into the life of the village and the cottage, and returned with note-books full of accurate and first-hand information. The greatest of his literary successes lies in the fact that he makes plain what a rich mine still remains to be worked. Here is folk-lore to be written down that would keep several men busy for years. Here is an important language to be studied. Here are customs of high antiquity yet remaining to be recorded and classified. It is to be hoped that Mr. Lawrence's book, besides bringing to him the high honour that is his due, and embodying a mass of most valuable facts and observations, will have a yet higher efficiency, in that it will get others to work along the lines, here laid down, to results yet more important and complete.

W. MARTIN CONWAY.

METALLURGICAL PROCESSES.

Metallurgy. An Elementary Text-book. By E. L. Rhead. (London: Longmans, Green, and Co., 1895.)

THE author's aim has been to present, within narrow limits, a clear and concise account of metallurgical processes, and he has done his work conscientiously, for much information has been included in the 271 pages of the volume, which also claims to be a "small handy book of reference.' This claim can, however, hardly be sustained, though the publication of the work is amply justified, mainly for the following reason. It is difficult to make the ordinary student of chemistry understand that metallurgical processes differ essentially from those he is taught in a chemical laboratory, for as regards "wet" processes the reactions which occur in large volumes of dilute liquids, held in tanks, are often more complicated than the chemical changes which may be studied with the aid of test-tubes or beakers. In dry processes also the student has to deal with problems which involve a knowledge of the influence exerted by mass and high temperatures, and his laboratory experience is often at fault. The sooner, therefore, that students are taught the need for special instruction in metallurgy the better, and a little volume like this one under review is to be welcomed, more especially as the author is careful to point out "that the equations given for reactions occurring at elevated temperatures only partially express the truth." He says that "details are only given when necessary for the sake of clearness"; and this reveals the weak point of his scheme. It is impossible to give details as to the extraction of individual metals from their ores in a book of this size, and it would have been better to have limited the range of the little volume to a consideration of the principles on which metallurgy is based.

There are several things which present themselves, even to a rapid glance through the pages, as needing change or modification. For instance, it is stated in the introduction that "a gold structure of the same strength as an iron one would be nearly nine times as heavy"; an illustration which is not very apt, as mere weight is not the only thing which prevents gold being used for constructive purposes. Standard gold would make a very fair gun, but it would be a costly form of armament. On p. 3, it is stated that "all metals, with the exception of chromium, have been reduced to a fluid condition by heat"; but chromium is no exception, as it is not difficult to fuse even the carbon free metal in the electric arc. Moissan has, in fact, shown that titanium is the least fusible metal known, though he succeeded in melting it. There is another use of the words "cold-short" than the one given on p. 4, for "cold-shorts"; and the student should be warned of this, as it is a point upon which an examiner would expect rigid accuracy. Turning through the pages, on p. 224 it is stated that during the roasting of certain silver ores the gold "is chlorinated, and thus dissolved out." This is practically not the case, though the mistake is not an unnatural one. The brief description, given on pp. 231–232, of hydraulic mining is very defective; the head is said to be "sometimes 200 feet," it really sometimes is as much as 500 feet. Somewhat ancient practice is described in relation to the stamp battery for crushing quartz. In describing the cyanide process for extracting gold, the author thinks that it would "displace the chlorination process if a cheaper method of making cyanide can be found"; but the progress of the very important McArthur-Forrest process has not, really, been in the least impeded by the cost of the cyanide. The reviewer has, however, been over-captious. He has persistently advocated teaching the methods of conducting

metallurgical processes by diagrammatic schemes such as the author has adopted; see p. 198, for instance. The one given for the blast furnace (p. 110) is certainly instructive.

The illustrations, of which there are nearly one hundred, are clear, but some of them are very old friends, while others are perspective drawings; and for a book like this, the reviewer would have preferred to see suggestive outlines and sketches, which the student could have transferred to his note-book with a few strokes of the pencil.

W. R.-A.

OUR BOOK SHELF.

Milk, its Nature and Composition; a Handbook on the Chemistry and Bacteriology of Milk, Butter, and Cheese. By C. M. Aikman, M.A., D.Sc. Crown 8vo. Pp. 173. (London: Adam and Charles Black, 1895.)

THE design of this little work is to give a short, popular statement of the more important facts concerning the chemistry and bacteriology of milk; and Dr. Aikman has succeeded admirably. A great deal of most valuable information is conveyed in a simple and eminently readable form, and it is a volume which is not only suitable for students in our recently started dairy-schools, but might well find a place in the library of any country-house. The general public is only very slowly awakening to the dangers which surround the consumption of dairy produce, and it requires the pressure of enlightened public opinion to produce the requisite reforms in the hygienic management of dairies. Dr. Aikman's volume, together with Dr. Freudenreich's "Bacteria in their relation to the Dairy," recently reviewed in these columns, should help a great deal in bringing about such reforms, which are not only of hygienic but of commercial importance to this country. In the section on the pasteurisation of milk, Dr. Aikman has overlooked an important fact, upon which the subsequent keeping power of such milk so largely depends, *i.e.* the *immediate* chilling of the milk after pasteurisation to a temperature below the point most favourable for germination. We think, in view of the recent valuable experiments, made in America and elsewhere, on the production of pasteurised milk on a commercial scale, and the importance of our adoption of a practice which has already gained considerable ground on the continent, Dr. Aikman might with advantage have entered more fully into this branch of the subject. Doubtless in a second edition Dr. Aikman will also expand somewhat the part devoted to cheese, and include some of the important and interesting results obtained by Bondzynski on the chemical composition of some varieties of cheese, published in the *Landw. Jahrbuch der Schweiz* last year. The illustrations accompanying the text are carefully chosen and well executed.

Elementary Physics. By John Henderson, B.Sc. (Edin.). Pp. 128. (London: Longmans, Green, and Co., 1895.)

IT may be well to remark at once that this is not a text-book of physics, but the first volume of a series of manuals designed solely for use in physical and electrical engineering laboratories. The present book is a general introduction to practical work in physics, and future volumes will be devoted to more advanced experiments. Altogether, eighty experiments are described, and are arranged in sections having the following succession: general physics, magnetism, electricity, heat, light, and sound. No serious attempt seems to have been made to connect the experiments in any particular order, so that, with few exceptions, they are independent of one another. A slight knowledge of physics is necessary before the student can understand and carry out the course of work described. This information may, however, be obtained from lectures given concurrently with the laboratory work, though the order of the practical course is not what most teachers follow in their lectures.

The experiments can be performed without any very elaborate apparatus, and we have no hesitation in saying that the student who works through them will by so doing obtain a sound knowledge of many important physical laws. The knowledge thus gained by direct observation is far and away better and deeper than that obtained by reading text-books.

Practical Trigonometry. By H. Adams, M.I.M.E. (London: Whittaker and Co., 1896.)

THE author of this small book is careful to point out that it is not a text-book; but it will be found useful to practical men, in enabling them to undertake the perusal of other than elementary works where a knowledge of trigonometry is essential.

The book is so arranged as to gradually disperse the difficulties to beginners in trigonometry, and it cannot but prove an incentive to further study. As an *aide-mémoire*, however, the absence of proofs, to secure brevity, will diminish its value for examinations where trigonometry is a special subject.

W. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Remarkable Sounds.

WITH reference to Mr. McKenny Hughes' letter on this subject, which appears in your issue of the 14th ult., and to his suggestion that it "would be of great help if we would get some exact data as to the distance at which the sounds of great guns, of blasting, or of waves, can be proved to have been heard," I would ask permission to be allowed to cite my experience on the north coast of Spain at the fishing village of Comillas, about twenty-four miles west of Santander. The bay which gives rise to the port is relatively small, and of inconsiderable depth inland; the south-east part of it is limited shoreways by cliffs of limestone, which rise to a height of about 120 feet, and somewhat overhanging the base or water-line. When the ground-swell—so characteristic of the Bay of Biscay—comes in to this bay, the breakers are very remarkable, and dangerous for small fishing-boats, being relatively high, and succeeding one another with great regularity. They break against the cliff mentioned with a thundering noise, and such that I have frequently heard them at eight miles' distance inland, although high and uneven ground lay between me and the coast, and the weather was relatively calm, so that the sound could hardly be favoured in its transmission by the wind. In stormy weather, and when the weather has been bad seaward, then the waves are even more terrible, and the sound heard still farther away.

Dublin, November 27. J. P. O'REILLY.

IT is a pleasure to me to see Prof. Darwin's note on curious sounds, in NATURE for October 31, since I have often been puzzled by what is obviously precisely the same phenomenon along the Bay of Fundy coast of New Brunswick, particularly about Passamaquoddy Bay, where I have been a great deal in the summer. Locally it is explained as the reports of the guns of Indians shooting porpoises off the islands of Campobello and Grand Manan; but, for several reasons, I never believed this: in fact, I have always been sure it must be due to some other cause, though I could think of no explanation. It is heard most often in summer, in rather still and warm weather, on those days when the heat-haze hovers upon the ocean, and appears to come from seaward.

W. F. GANONG.

Smith College, Northampton, Mass., U.S.A.

THE "humming in the air," to which Mr. Tomlinson calls attention in your last number, is noticed in White's "Selborne." "There is a natural occurrence to be met with upon the

highest part of our downs in hot summer days, which always amuses me much, without giving me any satisfaction with respect to the cause of it; and that is a loud audible humming as of bees in the air, though not one insect is to be seen. This sound is to be heard distinctly the whole common through, from the Moneydells to my avenue gate." (Vol. ii. p. 94, Macmillan's edition.) W. TUCKNELL.

November 30.

Fireball of November 22.

ON November 22, at about 6h. 51m. I observed, in a sky quite overcast, a brilliant prolonged flash quite different to lightning. The whole firmament was illuminated for more than a second with an intensity greater than that which the full moon could have occasioned, and the glow seemed strongest in the south-east. Not a star was visible, but though the origin of the outburst could not be observed, no doubt existed that a fireball of the most brilliant type had fallen.

Mr. R. Sheward's letter from Eastbourne (NATURE, November 28, p. 78) affirms this conclusion, and it would be well if he or others who witnessed this striking object would give particulars as to the path it traversed. Appearing, as it did, at a convenient time in the evening, it must have had many observers, though unfortunately in the west of England the sky was veiled in cloud. For purposes of calculation it is not sufficient to have descriptions which merely indicate the general direction of the meteor's flight, as, for example, from east-north-east to west-south-west. We require to know the altitudes as well as the azimuths of the initial and terminal points, or the co-ordinates read from a celestial globe or star chart. A particular account of the path relatively to the stars near would be equally useful.

It is to be hoped that such information will be forthcoming in regard to this splendid meteor, which, from the manner in which it illuminated the clouded sky, must have been a very exceptional object of its class.

At this period in November many large fireballs are directed from the region of Taurus; but it is impossible to say, in the absence of necessary details, whether or not the fine meteor of November 22 last belonged to the Taurid stream.

Bristol, November 29. W. F. DENNING.

IN reference to the letter of Mr. Sheward in last week's NATURE, it may be of interest to mention that whilst talking to a friend in a dark road in this locality on the evening of November 22, the sky at the time being entirely overcast, we were startled by the sudden illumination of the clouds as if by the outburst of a bright light above them. The effect was similar to that which might have been produced by the explosion of a large magnesium shell sufficiently brilliant to illuminate the entire sky. The light appeared suddenly, but faded out gradually, its estimated duration being three seconds. It appeared to me to emanate from a point in the north-east, at an altitude of about 60°. My friend, whose face was turned in the opposite direction, could not localise the outburst, though he remarked that the light suffused the clouds almost equally in the west and south-west. I noted the time as 6 48 p.m., which so nearly coincides with that mentioned by Mr. Sheward, that although so far apart it seems probable that we were witnesses of the same phenomenon. R. T. LEWIS.

Ealing, W., December 2.

A Joint Meeting of Associations for the Advancement of Science.

MY suggestion for a joint meeting of the British, Australasian, and American Associations for the Advancement of Science at San Francisco in 1897, at some time conveniently near to that of the Toronto meeting of the British Association, published in your issue of October 24, meets favourable reception in the United States and Canada. I have recently received a letter from Sir Wm. C. Van Horne, President of the Canadian Pacific Railroad, and a member of the British Association, in which he says that he will instruct his superintendent to reopen negotiations with other transcontinental roads to secure favourable rates of transportation. Prof. Joseph Le Conte, who has for years given earnest effort to secure a meeting of the Association on the Pacific coast, writes from Berkeley, California: "I will certainly interest myself in your scheme . . . I am glad you are moving the affair so early, and thank you for drawing my attention to it."

The following is a copy of a letter just received from the Mayor of San Francisco:—

MY DEAR SIR,—

Your communication of October 9, 1895, was received and thereafter forwarded to the Board of Supervisors.

That body, on October 28, 1895, passed a resolution, and it is herein inserted in print.

"*Resolution No.* 13, 120 (*Third Series*).

"Resolved—That his Honour the Mayor be, and is hereby empowered and requested to invite the American and Australian Associations for the Advancement of Science to meet in this city in 1897; also, to invite the British Association of the same character to meet said Associations in this city as invited guests, and to that end to take such action as may be proper to arrange for their comfort and accommodation on that occasion.

"And the clerk is hereby directed to advertise this resolution as required by law.

"Board of Supervisors, San Francisco, October 28, 1895."

Pursuant thereto, an invitation is thereby sent to your Society—the American Association for the Advancement of Science.

It is my sincere hope that San Francisco may have the good and rare fortune to receive the visit of all three of these distinguished bodies.

The gathering of the world's chosen scientists is at once recognised as of high importance to our Municipality.

Its citizens will feel honoured in extending a generous welcome to men eminent in the cause of truth, and representing the three great branches of the Anglo-Saxon races.

Should this invitation be accepted, an early notification thereof is requested.

Invitations have been sent to the British and Australian Associations. (L. S.) ADOLPH SUTRO.

Application will be made to Congress at its session, which begins on the first week of December, for an appropriation to assist the American Association for the Advancement of Science towards defraying the necessary expenses of holding a meeting so distant from the homes of most of our members. It is, of course, impossible to foretell what Congress may be willing to do in the matter; but as it has never before been asked to subsidise the Association, we may hope that some appropriation may be secured. WM. H. HALE.

Brooklyn, November 18.

The Metric System of Weights and Measures.

THE adoption of the metric system in this country can be best effected by first familiarising the people with it for some years. I would suggest that the following would form a good beginning:—

(1) Its adoption by the Post Office. At present the weight of a foreign letter that will go at the minimum rate, must not exceed ½ oz. if posted in England, while 15 grammes are allowed on the continent, which is rather more. The 15 grammes limit should be adopted in England for foreign postage, and 30 grammes for inland postage. Parcels and newspapers should also be charged according to the metric system.

(2) The metric system should be employed by the Meteorological Society and Meteorological Office. At present our weather statistics cannot be compared directly with those published on the continent. The same course should be also followed by other sciences (*e.g.* geology, astronomy, &c.) that still use miles, yards, feet, &c.

(3) Government topographical and geological maps should all bear a scale of metres and kilometres.

There are, of course, many other ways in which the metric system could be brought before the public.

December 2. JOHN W. EVANS.

"Dendrexetastes capitoides."

DR. FORBES has been kind enough to send me for examination the typical specimen of *Dendrexetastes capitoides* of Eyton, now in the Derby Museum, Liverpool, to which he has called attention in a letter in NATURE of October 24 last (NATURE, vol. lii. p. 619). I have compared it with specimen *a* of *Dendrexetastes temmincki* in the British Museum, and do not hesitate for a moment to say that they are referable to the same species. Both are from Cayenne, and of the ordinary unmistakable "Cayenne make." But it is quite true that, as pointed out by Dr. Forbes, the cross-bands on the belly, which

are very visible in the British Museum specimen, are quite non-apparent in the Derby Museum specimen. These cross-bands are, in all probability, remnants of the immature plumage, the British Museum specimen being not quite adult. I was, therefore, wrong in using this character ("Cat. Bds.," xv. p. 140) to separate *Dendrexetastes temmincki* from *D. devillii*, which, however, are quite different species, easily distinguishable by other characters. But *D. capitoides* = *D. temmincki* in my decided opinion, as has been stated in the "Catalogue."

P. L. Sclater.

"The Zoological Record."

In reference to the note in Nature of November 21, about the *Zoological Record* for 1894, I must ask to be allowed to say that it is stated in the preface that Prof. Hickson could not undertake a record of Cœlenterata. Consequently there has been no failure of contract on his part. Prof. Hickson has been a valued contributor to the *Record* for several years, and his work was always ready at the time agreed on.

Cambridge, November 23. D. Sharp,
Editor of the *Zoological Record*.

THE LONDON UNIVERSITY.

Fortune so far has not been too kind towards the efforts made for adding teaching functions to the existing University of London. As already chronicled in Nature, the answer of the late Government to the request of the deputation to Lord Rosebery from institutions mentioned in the Report of Lord Cowper's Commission was the introduction of Lord Playfair's "University of London Act, 1895," enacting the appointment of a Statutory Commission to give effect to the recommendations of the Royal Commission. Before it had been read a second time, the Government went out of office and the Bill was dropped. From reports which have lately appeared in the press, it would seem that on June 13 a deputation from the members of Convocation hostile to the scheme waited on the Duke of Devonshire and Lord Salisbury, then in Opposition, and were led to believe that these statesmen were not unwilling to support an amending clause to Lord Playfair's Bill, which would entail the scheme, when arranged by the Statutory Commission, being submitted to Convocation for approval in the manner prescribed for a senatorial election, *i.e.* by voting-papers. And by July 1, Sir John Lubbock, in seeking re-election for the University, had pledged himself to oppose the Statutory Commission Bill unless such a clause were inserted, and comes into line with those against whom he voted in the Senate a year previously. Following this, came the Duke of Devonshire's reference on August 15 to the "strong opposition taken by a large and not unimportant section of Convocation" to the scheme of Lord Cowper's Commission, coupled with the announcement that legislation on the subject would not be undertaken in the short session then commencing.

Judged from such incidents, the outlook could not be regarded as reassuring, and with the return of Ministers to town, steps have been taken to bring to the notice of the Government the urgent necessity of dealing with the burning question of a Teaching University for London. On November 21 the delegates represented on the deputation to Lord Rosebery, met at the University of London, and unanimously passed the following resolution:—

"That the Government be requested to introduce, at an early date, a Bill, similar to Lord Playfair's London University Commission Bill, 1895, appointing a Statutory Commission to carry out the recommendations of Lord Cowper's Commission, but with an added clause giving [in accordance with precedent Acts of similar tenor[1]] to all Institutions or persons directly affected by any Statute or Ordinance proposed by the Statutory Commission, a right of appeal to the Privy Council for the disallowance or alteration thereof, previous to such Ordinance being laid before Parliament for confirmation."

The Duke of Devonshire, on Thursday last, received a deputation in support of this resolution, the delegates present representing not only the institutions named in the Report of Lord Cowper's Commission, but also the members of that and of the earlier (Lord Selborne's) Commission on a Teaching University for London, as well as members of the recent Bryce Commission on Secondary Education. The deputation was introduced by Lord Kelvin, and its views were enforced by Prof. Rücker on behalf of the Senate of the University of London: Dr. Allchin for the Royal College of Physicians, Mr. Heath for the Royal College of Surgeons, Sir George Young (University College), Principal Wace (King's College), Dr. Frederick Taylor (Medical Schools), Principal Whitehouse (Nonconformist Theological Colleges), Sir Henry Roscoe (Association for promoting a Professorial University for London), Prof. Silvanus Thompson (Annual Committee of Convocation), and Mr. Anstie (Committee of Graduates).

In the presence of so emphatic an expression of the unanimity not only as to the need for but also the method of the reorganisation of the present University existing among the many institutions and persons interested in the settlement of this grave question, a sympathetic reply might surely have been expected from the official head of the Education Department. This, however, was not to be the case. The Duke, after conceding the representative character of the deputation, made no further reference to the manifold interests represented by the delegates; no reference to the needs of higher education in London; no reference to the widespread recognition of the necessity for a Teaching University without which, in view of the conflicting nature of the interests concerned, little approach towards a united appeal for a Commission with executive and judicial powers for their settlement could have been gained. On the contrary, his reply dwelt on the difficulty of securing the present status of the external students under the scheme of Lord Cowper's Commission, while admitting that the scheme and deputation were at one in insisting that this should be maintained unimpaired; on his desire to obtain, if possible, an expression of opinion on the subject from the external students, and on the differences in opinion which had arisen in Convocation about the scheme. In Convocation the Duke of Devonshire recognised three sections—those who accept the scheme with such modifications as may be made by the Statutory Commission, those who are irreconcilable, since they express the view that if a Teaching University for London is needed it should be founded apart from the existing University, and those who are of opinion that it would not be enough for the amendments they desired introduced in the scheme to go merely as recommendations to the Commissioners when appointed, whence their claim for a veto on the scheme when arranged, to which we may add a fourth, viz. the large proportion, nearly one half of the members, who, so far, have not been beguiled by the foregoing three to express any opinion at all. And recognising only these three, he dwelt on the expediency of everything possible being done to conciliate the opposition, if only on the ground that it is extremely desirable that the Bill, if it comes before Parliament, should come before it in a shape which should excite as little opposition as possible.

It is not too much to say that, in tendering this advice, the Duke showed that he had not had time to balance the relative importance of the views laid before him by the deputation from some members of Convocation in the summer, and those which had been so strongly urged by the delegates whom he was addressing. Had it been otherwise, the disparity between the interests involved is

[1] Oxford and Cambridge Act, 1877, sec 46.
Scottish University Act, 1889, sec. 20 (*a*).

so evident that advice to treat, apparently on a footing of equality, with a section of Convocation would never have been given to the deputation before him—a section of Convocation, be it remembered, which has rejected the conciliatory overtures of the Annual Committee of Convocation,[1] and has made common cause with the irreconcilables in promoting opposition to the scheme.

The Duke's reply has at least made one point clear. We now know that between the institutions concerned with higher education in London, and the realisation of their wishes, there only stands the opposition of a section of the graduates of the present University. Thus no alternative is left but to deal with the question again from this point of view. It must not be forgotten that Convocation, in the manner prescribed by the charter, has twice declared in favour of the scheme of Lord Cowper's Commission. But even were the members of Convocation as unanimous in opposition to the scheme as they are divided in opinion as to what measure of support should be accorded it, is it right or just that the organisation of London's unrivalled facilities for higher education should be delayed at the instance of a body of graduates of a State institution? The precedents are all the other way, as in the case of the Queen's University for Ireland, where the hostile vote of its Convocation was set aside by Lord Beaconsfield's Government, and the University reorganised as the Royal University for Ireland. For what is the position? The University of London, according to the clearly implied opinion, both of Lord Selborne's and Lord Cowper's Commissions, and to the widely-expressed opinion of those outside the University most competent to judge on educational matters, does not perform the duties now required of it. Lord Cowper's Commission, in its Report laid down the lines on which the University may be reorganised, so that it can become a Teaching University for London without interference with its present work. The principles of the proposed reconstruction have been accepted by all concerned, as well as by outside opinion, with a degree of approval no less remarkable for its wide extent than for the contrast it affords with the reception accorded to all previous schemes. But this approval is wholly conditional on the reorganisation being effected by legislative authority as recommended in the Report, a requirement so displeasing to a section of Convocation that to secure its assent to this procedure nothing less is demanded than a right to veto the scheme when arranged by the Statutory Commission, should the "opinion of Convocation as a whole," ascertained by voting-papers, be unfavourable to it. Is it not a truly Gilbertian idea that the graduates of a State-created, State-maintained Examining Board should be put in a position to veto the action of the State itself? The War Office clerks might with about as much reason have insisted that the scheme for the reorganisation of the War Office should be submitted to a *plébiscite* of their body for approval before it appeared in the Orders in Council.

The misconception which gives the name of University to the examining body at Burlington Gardens extends, perhaps not unnaturally, to the Convocation of its graduates, and mischievous expressions such as the "opinion of Convocation as a whole" find a too ready currency. Convocation, if it means anything, means an assemblage for the discussion of matters affecting itself or the body it represents, and, save in the case of the election of members of the Senate, where no useful purpose would be served by the public discussion of the merits of the candidates, decisions arrived at in its meetings are the decisions of the Convocation of the University. Whatever the opinions of members absent from the meetings of the Convocation, they have as much weight, or as little as those of members of Parliament absent from a division, and as the result of the division on Mr. Brodrick's famous motion showed, it is the opinion of the members present, and not that of the House of Commons "as a whole," which determines the fate not only of measures but ministries.

The necessity for a Teaching University has now become a "London question" of the first importance, and is becoming recognised as such by the metropolitan press. Matters obviously cannot be allowed to remain in their present position, and in the fact that he has still to be convinced an incentive will no doubt be found by those in charge of this matter to see that the misconceptions under which the Lord President labours are as far as possible removed. That the true inwardness of the proposal to make Convocation the arbiter in this great question is gaining public recognition cannot be doubted when "the small group whose views are represented by Sir John Lubbock, Dr. Collins, and Dr. Napier" is plainly told by the *Morning Leader* that its attitude is that of Demetrius the silversmith, and by the *Star* that "no Statutory Commission could for a moment accept such a position" as that proposed for it under the postal veto scheme. The following paragraph from *The Times* is so much to the point that we gladly give it further publicity :—

"We are sorry to see that the Duke of Devonshire speaks almost with bated breath of the reference of the question to a Statutory Commission. It would be 'a somewhat strong proceeding,' he says, to interfere in this way with the rights conferred on the Convocation of the University of London by the charter now in force. We cannot help feeling that this is a rather strange objection in the mouth of a statesman who has taken a leading part in the Liberal legislation of the past quarter of a century. Was it not by Statutory Commissions that sweeping reforms were introduced in the educational system and even the proprietary rights of the Universities of Oxford and Cambridge and their constituent colleges? Does the Duke of Devonshire imagine that those reforms would ever have been carried through if it had been left to the Convocation of Oxford or to the Convocation of Cambridge to give or withhold its sanction? On what ground, rational or sentimental, is an immunity from the reforming hand of Parliament claimed for the University of London which was denied to the historic and national foundations of Oxford and Cambridge? Indeed, the Convocation of the University of London has itself accepted in general terms the principle of the plan embodied in the Report of the Cowper Commission ; but the Duke of Devonshire is probably right in refusing to take this as an absolutely final expression of opinion. The Duke, however, goes further than this. He appears to insist that some additional means should be devised for ascertaining the views of those whom he calls the 'external students.' If unanimity, or anything approaching to it, is to be sought for as the result of this inquiry before the reforms unanimously demanded by the friends of higher education in London are initiated, the establishment of a Teaching University here, for which educational reformers have been struggling for years, will be substantially relegated to the next generation. This is a lame and impotent conclusion from which we should have thought the practical and positive temper of the Duke of Devonshire would recoil. The Parliamentary difficulties in the way of passing a Bill that meets with any strenuous resistance need not be insisted upon. The present Government, supported by an immense majority, and including so many distinguished statesmen, will find it no hopeless task to overcome such difficulties, especially as the Opposition are committed by Lord Playfair's Bill

[1] *Vide* Report of the Annual Committee presented to Convocation at its meeting on January 22, 1895.

to this very settlement of the question. But the problem will never be solved if the party of resistance are encouraged by being told that the acquiescence of the country graduates is indispensable, and that a measure brought in by the strongest Administration of the century cannot be passed if a handful of malcontents oppose it."

With such expressions of opinion as these before us we cannot doubt but that London will yet be roused to a sense of what it will lose if advantage is not taken of the present golden opportunity.

HENRY SEEBOHM.

THE death of Henry Seebohm was announced in one of the "leading dailies" last week, as that of a member of an eminent firm of steel-manufacturers. Steel-manufacturer Seebohm was, no doubt, and his steel was good; but his name will be remembered as that of an acute and hard-working naturalist long after the quality of his steel is forgotten.

Henry Seebohm was one of a family of Quakers of Scandinavian origin, as the name shows, but settled for several generations in England. He was born in 1832, at Bradford in Yorkshire, and educated at the Quakers' school in York. His father, who was a practical man and thought everybody should begin at the beginning, started him in life as a grocer's shop-boy, in order that he might be taught to tie up paper-parcels properly. After many vicissitudes in business, Seebohm settled down as a maker of pot-steel at Rotherham, and in due time achieved a handsome competence. From his earliest days devoted to natural history and especially to ornithology, Seebohm spent all his leisure in the study of birds, and made short excursions into different parts of Europe in order to obtain personal acquaintance with some of the rarer species. It was not, however, until about twenty years ago that his business pursuits permitted him to devote much time to scientific work. In 1875, in company with his friend Mr. J. Harvie Brown, he made his first great excursion to the valley of the Lower Petchora in North-east Russia. Of the remarkable ornithological discoveries effected on this occasion an account was first published in *The Ibis* for 1876. But a complete and most attractive narrative of the whole journey was subsequently prepared by Seebohm, and issued in 1880 under the title of "Siberia in Europe." In 1877 a longer and more adventurous journey was carried out into the Far East. On this occasion Seebohm visited the valley of the Yenesay, and in 1882 published his "Siberia in Asia" as a pendant to his former volume.

After this Seebohm commenced to put together the facts that he had accumulated, and the conclusions that he had arrived at on his much-loved subject of British birds. The first volume of his "History of British Birds and their Eggs" was issued in 1882. In 1885 the subject was concluded by the issue of the third and fourth volumes. It may be truly said that no other book of the sort has been prepared on the base of such wide and varied experiences. Having acquired from a brother ornithologist a special collection of wading-birds, Seebohm next turned his attention to this branch of ornithology, which had also particular attractions for him in connection with the migrant habits of this order, and in 1888 issued a beautifully illustrated quarto work "On the Geographical Distribution of Plovers, Sandpipers, and Snipes," which was, in fact, a complete "Monograph" of the birds of the order Limicolæ. He also wrote two treatises on the "Classification of Birds," the last of which was only published in the present year.

Seebohm was a most liberal contributor to the bird-collections of the British Museum, and from time to time made many very handsome contributions to them. He would purchase and present without the slightest hesitation any specimens that came into the market, if he thought there would be a difficulty in their acquirement by the Museum. He gave to the Museum the whole of his unrivalled series of eggs, and had it arranged along with the rest of the collection of these objects under his own personal supervision. He was also the compiler of the fifth volume of the great catalogue of birds published by the Trustees, which was issued in 1881. This related principally to the thrushes—a group with which Seebohm was specially familiar. In fact, he has long had in preparation a complete monograph of this group of birds, with coloured illustrations of every species, but has unfortunately left it unfinished at his decease.

Seebohm was elected a Fellow of the Zoological Society and of the British Ornithologists' Union in 1873, and from that date onwards was a leading spirit in the conduct of both these Societies, and a constant contributor to their publications. He was never elected a Fellow of the Royal Society, though put up as a candidate, and very strongly supported. Unfortunately occult influences interfered with his attainment of this honour. Seebohm, though one of the kindest natures possible, was occasionally a severe critic, and gave offence to sensitive individuals by stating the truth too plainly. The loss of an only son some years ago was a sad blow to Henry Seebohm; but he recovered this shock to a great degree, and returned to his usual pursuits. His last and fatal illness was consequent, as he believed, on an attack of influenza, which took place last spring. He died on the 26th ult., at his residence in South Kensington, where he had got together a splendid ornithological library and an almost unrivalled collection of British birds, leaving a vacuum in the ranks of living naturalists which it will be very difficult to fill.

NOTES.

THE first meeting of the General Committee formed for the purpose of establishing a memorial to the late Prof. Huxley was held on Wednesday, November 27, when it was resolved—"That the memorial do take the form of a statue to be placed in the Museum of Natural History, and a medal in connection with the Royal College of Science; and that the surplus be devoted to the furtherance of biological science, in some manner to be hereafter determined by the Committee, dependent upon the amount collected."

IT will be remembered by our mathematical readers that a Committee, including the names of many eminent mathematicians in both hemispheres, was formed in 1893 to obtain funds for a memorial to the renowned master of geometry—Lobatchefsky. The report of the Committee on what has been done in the matter has just been issued. The total sum received up to May last was 9071 roubles (£1417), and when all expenses had been paid the amount available for the memorial was 8840 roubles (£1381). This sum enables the Committee to carry out the double intention of founding an international prize for geometrical works, especially for those belonging to non-Euclidean geometry, and also to erect a bust of Lobatchefsky. Six thousand roubles have been put by to found the prize, which will consist of 500 roubles (nearly £80), to be given every third year for the best geometrical works or memoirs. The memoirs may be written in Russian, French, German, English, Italian, or Latin, and must be sent to the Physico-Mathematical Society at Kazan, at least a year before the adjudication of the prize. The first prize will be awarded on October 22 (November 3, new style), 1897. The sum remaining over and

above that devoted to found the prize will go towards erecting two busts of Lobatchefsky—one outside the University of Kazan, and the other in the interior of the University Buildings. The former bust, with its pedestal, will cost three thousand roubles, of which two thousand will come from the Lobatchefsky fund, and one thousand from the Municipal Council of Kazan. In the case of the second bust, which will be placed in the meeting-room of the University, two hundred roubles will be given from the fund; and the remainder of the cost will be defrayed by the Professors. All memoirs referring to Lobatchefsky and his geometry, together with the printed papers and manuscripts of the great geometer himself, are to be arranged in a separate collection, and named the "Bibliotheca Lobatcheoskiana."

MR. JOHN D. ROCKEFELLER'S recent gift of an additional million dollars (£200,000) to his munificent donations to the University of Chicago, and his promise of a similar contribution of two million dollars, were noted at the beginning of last month. Our readers will be interested to read Mr. Rockefeller's letter to the Trustees of the University, printed in *Science* of November 15:—"October 30, 1895. To the Trustees of the University of Chicago, T. W. Godspeed, D.D., Secretary. Gentlemen: I will contribute to the University of Chicago \$1,000,000 for endowment, payable January 1, 1896, in cash, or at my option, in approved interest-bearing securities at their fair market value. I will contribute in addition, \$2,000,000 for endowment or otherwise, as I may designate, payable in cash, or, at my option, in approved interest-bearing securities at their fair market value, but only in amounts equal to the contributions of others, in cash or its equivalent not hitherto promised, as the same shall be received by the University. This pledge shall be void as to any portion of the sum herein promised, which shall prove not to be payable on the above terms, on or before January 1, 1900. Yours very truly (signed), JOHN D. ROCKEFELLER." These gifts, remarks our contemporary, make the entire amount of Mr. Rockefeller's donations to the University of Chicago about 7,600,000 dollars, probably the largest gift ever made by an individual for educational or public purposes."

A QUARTER of a million dollars (£50,000) was, we understand from *Science*, granted by the last U.S. Legislature to the Regents of the University of California for the erection of a suitable building for the departments situated in San Francisco, the Colleges of Law, Medicine, Dentistry, Pharmacy, and Veterinary Surgery. Mr. Adolph Sutro, Mayor of San Francisco, has given a tract of thirteen acres as a site for the building. On the adjoining thirteen acres Mr. Sutro proposes to erect a building for his magnificent library of about two hundred and fifty thousand volumes.

IT is announced that at the instance of the Bureau des Longitudes, the French Minister of Marine has provided ships, men, and instruments for some seven expeditions, which are to make accurate (and as far as possible simultaneous) observations in different parts of the globe. One of the chief defects of the present state of knowledge of this important branch of terrestrial physics arises from the fact that past observations have been made in various ways, under very various conditions, and that a great part of it depends upon the scarcely scientific records of ordinary seamen. The French expeditions are to observe strict uniformity in their method of observation, and cannot fail to enhance the value of the work which England and America have begun in this direction.

AT the recent annual meeting of the Royal Society of Edinburgh, the following officers and members of Council were elected for the ensuing session:—President: The Right Hon. Lord Kelvin, F.R.S. Vice-Presidents: Prof. Copeland, Prof. James Geikie, F.R.S., the Hon. Lord Maclaren, the Rev. Prof. Flint, Prof. J. G. McKendrick, F.R.S., and Prof. Chrystal. General Secretary: Prof. P. G. Tait. Secretaries to Ordinary Meetings: Prof. Crum Brown, F.R.S., and Dr. John Murray. Treasurer: Mr. Philip R. D. Maclagan. Curator of Library and Museum: Dr. Alexander Buchan. Councillors: Dr. Alexander Bruce, Prof. Frederick O. Bower, F.R.S., Mr. A. Beatson Bell, Sir Arthur Mitchell, K.C.B., Prof. T. R. Fraser, Mr. Robert Munro, Dr. M. D. Noel Paton, Mr. C. G. Knatt, Sir W. Turner, F.R.S., Sir Stair Agnew, K.C.B., James Burgess, and Dr. John S. Mackay.

AS one of the results of the late Medical Congress, the *Pharmaceutical Journal* states that the Government of India have decided to institute an inquiry into the subject of the desirability of a more extended use of indigenous drugs. The Committee to which the Indian Government has decided to refer the whole question consists of Dr. George Watt, C.I.E., Surgeon Lieut.-Colonel C. J. H. Warden; and Brigade-Surgeon Lieut.-Colonel George King, F.R.S., C.I.E., Surgeon Lieut.-Colonel J. F. P. McConnell, and Rai Bahadur Kanny Loll Dey, C.I.E. The points to which the Government of India has particularly invited the attention of the Committee, with a view to their careful consideration, are the practicability as well as the utility of (*a*) encouraging the systematic cultivation of medicinal plants indigenous to India; (*b*) encouraging the increased use in medical depôts of drugs of known therapeutic value; and (*c*) sanctioning the manufacture of stable preparations of certain drugs at the depôts. With regard to these points, the Government of India desires that the members of the Committee shall consider, and report their opinion, as to the action which would be best calculated to give the suggested encouragement. The Committee will further consider, from a practical point of view, the question of initiating, as a Government measure, experiments to test the reputed therapeutic value of indigenous drugs.

THE next session of Parliament will, the *British Medical Journal* remarks, have before it a scheme for providing a supply of sea water for London and certain places on the route. The intention is to take in the water from the sea opposite Lancing, in Sussex, where all the pumping machinery will be situated. It will be pumped thence to a large reservoir in an elevated position at Steyning, whence it will flow by gravitation to another reservoir at Epsom. From this reservoir it will be distributed over London, the parts to be first supplied being the West-end and central portions. It is stated that local authorities will be supplied with sea water for flushing sewers, watering streets, and other public uses, such as swimming baths, and that sea water baths will be supplied to hotels, hospitals, schools, &c. As to any relief to present sources of water supply by using sea water for public purposes, it should be mentioned that the quantity proposed to be provided is stated to be only 10,000,000 gallons per day, while the average daily supply of water to London amounted in 1893 to over 190,000,000 gallons. If the scheme is carried into effect, it will have an important bearing upon the health of London.

ON Friday last, the new Museum of Natural History which has been erected at Perth by the Perthshire Society of Natural Science, at a cost of about £4000, was formally declared open by Sir William Flower, in the presence of a large and representative gathering. Mr. Henry Coates, the President of the Society, occupied the chair, and, in introducing Sir William Flower, he remarked that the idea of forming a Museum had been kept before their Society from its commencement, twenty-eight years ago. The first attempt to form a collection dated from 1869. In 1877 the late Sir Thomas Moncreiffe brought

forward a comprehensive scheme, which ultimately resulted in the erection of the Moncreiffe Memorial Museum. The available space was rapidly filled up, and in 1885 Dr. Buchanan White suggested a scheme for the enlargement of the premises. The scheme was embarked upon in 1892, and by the generous support of friends, and in particular the donation of Sir Robert Pullar, it had now reached its present successful completion. Sir William Flower, in declaring the Museum open, said he thought that this epoch in the history of the institution might mark a distinct advance in the educational history of the country. The foundation of such societies as the Perthshire Natural Science Society in all the principal centres of population was a proof that they fulfilled a natural want in the human mind in its present stage of development. Of the general value of museums, using the word in its widest sense, as collections of works of art and of nature, in the intellectual advance of mankind, there could be no question. How could science be studied without ready access to the materials upon which knowledge is built up? In many branches of science, especially those commonly called natural history, the progress was mainly commensurate with the abundance and accessibility of such materials. All would recognise the gradual development of the conception that the museum of the future was to have for its complete ideal not only the simple preservation of the objects contained in it, but also their arrangement in such a manner as to provide for the instruction of those who visited it. The value of a museum would be tested not only by its contents, but by the treatment of those contents as a means of advancing knowledge. What a museum really depended upon for its success and usefulness was not its building, not its cases, not even its specimens, but its curator. They might as well build a church and expect it to perform the duties required of it without a minister, or a school without a schoolmaster, or a garden without a gardener, as to build a museum and not provide a competent staff to take care of it. Complimenting the directors on the objects they had sought after in the arrangement of their museum, which was to provide a good local collection of natural products, as well as the formation of a type collection, Sir William Flower said every specimen should have its definite purpose, and he quoted the saying of Dr. Brown Goode that an efficient museum might be described as a collection of instructive labels, each illustrated by a well-selected specimen. Advocating the appointment of a paid curator, he said the great principle of expending public money upon purposes of education, though a comparatively new one, was now conceded upon all sides. The cost of supporting a few really efficient museums would be a mere trifle compared with the hundreds of thousands spent upon far less efficient modes of educating and elevating the people. He commended to the consideration of those who controlled the pecuniary funds of the city the great benefits they might confer on education by assisting to guarantee the stability of the Institution, which noble voluntary efforts had brought into the condition which enabled him to declare it open.

THE Gesellschaft für Erdkunde of Berlin has elected Mr. Scott Keltie, Dr. H. R. Mill, and Mr. E. G. Ravenstein, Corresponding Members, as a recognition of their work at the late International Geographical Congress.

THE Paris Academy of Sciences have elected M. Lannelongue Member of the Section of Medicine and Surgery, in the place of the late Prof. Verneuil. M. Charles Monod has been elected to succeed Prof. Verneuil as a Member of the Paris Academy of Medicine.

DR. G. LAGERHEIM (Trömso) has been appointed Professor of Botany and Director of the Botanical Institute to the University of Stockholm.

THE second series of lectures arranged by the Sunday Lecture Society begins on Sunday afternoon, December 8, in St. George's Hall, Langham Place, at 4 p.m., with a lecture by Sir Benjamin Ward Richardson, F.R.S. Lectures will subsequently be given by Mr. J. Churton Collins, Prof. Arthur Smithells, Prof. Vivian Lewes, Prof. Percy Frankland, F.R.S., Dr. Karl Leutzner, and Dr. Andrew Wilson.

A CORRESPONDENT in the United States writes:—"At the elections this month several very important matters not of a political nature were decided. In the State of New York, the measure to expend $9,000,000 on the State canals was approved by a large majority. The Erie Canal will be made nine feet deep, and somewhat widened, and improved locks will be built. Similar improvements will be made on the Oswego and Champlain Canals. The work will be pushed on rapidly, and facilities provided for the use of electric-motive power, to be furnished by the Falls of Niagara."

IN June 1894, Dr. A. Donaldson Smith, a young American physician, left England for an expedition across Somaliland to Lake Rudolf. He was accompanied by Mr. Gillett, who was recalled to England a few months later, and by Mr. Dodson, who acted as collector and taxidermist. The attempt to march straight from Milmill to Lake Abbai was frustrated by the Abyssinians, and Dr. Smith returned to the Webi Shebeyli. He left there in February last in order to try to reach Lake Rudolf by another route, and as he was not heard of till he arrived at Lamir in November, some anxiety was felt as to his safety. He has, however, brilliantly carried out the whole of his plans, and achieved the march from the coast of Somaliland to that of British East Africa, which has been attempted repeatedly since it was first projected by Burton. Dr. Smith has explored the country to the north of Lakes Rudolf and Stephani and Abbai, connecting the route of Teleki with that of the Abyssinian travellers. He also reports (*Times*, 2nd inst.) a race of dwarfs in this region. These must be the Doko, first reported by Harris in 1844 from information supplied by a native of Shoa, and whose existence has been repeatedly reaffirmed. Lake Rudolf has only previously been reached by Teleki and Höhnet; at the time of their visit the lake was brackish, but it is now fresh. Dr. Smith has brought back large collections, including fish from Rudolf, Stephani, and Abbai. He does not seem to have seen the snow-clad Wosho, reported by Abbadie; Mount Wosho will probably therefore have to be wiped off the map. Dr. Smith is expected to read his paper at the Geographical Society in January, when important additions to our knowledge of this part of Africa may be expected.

FURTHER interesting additions to our knowledge of the African fish-fauna may be hoped from the collection of Miss Kingsley, who returned on Saturday, 30th ult., from a courageous journey on the West Coast. Miss Kingsley ascended the Ogowe River to the French station at Njole, and thence journeyed northward to the Rembwe, a tributary of the Gaboon. She visited the Crystal Mountains. Subsequently she ascended the Cameroons, and climbed the highest peak, the summit of which was first reached by Burton and Mann in 1862. Miss Kingsley's field of exploration is sufficiently well known to preclude important geographical results, but many valuable ethnographical observations have been made and zoological specimens collected.

A CURIOUS method of silvering mirrors has recently been patented by M. Hans Boas, of Kiel (says *Engineering*). It is based upon the fact that, when one of the heavy metals forms the cathode of a vacuum tube, containing a trace of hydrogen, the metal is volatilised by the current, and is deposited as a firmly adherent and highly polished layer on the walls of the tube. The mirror thus produced is said to be of much greater brilliancy than can be obtained by ordinary methods.

THE *Times of Ceylon* learns that it is in contemplation to introduce the electric light into the Sivan Hindu Temple at Kochicadde, on the main road to Mutwal, Ceylon. The premises of this Hindu place of worship are at present lighted by gas, and the trustees propose to substitute the electric light for gas; but whether they will introduce it into the interior of the building, is a matter which is now under their consideration. It is said that, if the Sivan Hindu Temple introduce the innovation, the trustees of equally wealthy temples are sure to follow the example set by their brethren.

IN reference to his letter on the "Jelly-fish of Lake Urumiah" (NATURE, 1892, p. 294), Mr. Sclater informs us that he has lately received a letter from Mr. F. F. Irving, of the English Mission at Urmi, in Persia, stating that Mr. Irving has lately visited the lake, and has found, as has been described by Mr. Curzon, numerous specimens of the supposed jelly-fish in its waters. Mr. Irving says that it resembles a tiny shrimp when swimming, but that as soon as it is brought out it succumbs into a sort of gelatine mass without shape. Measures are being taken to secure the transmission home of specimens of this interesting organism.

AN instance of concerted harmony and measured time-keeping on the part of certain insects, described by Dr. G. M. Gould, of North Carolina, in a recent number of *Science*, has drawn several letters from entomologists on the subject. Probably most people would hardly recognise music in the stridulous noise made by members of the group Crytophyllus, or "Katydids," and would express surprise at the suggestion that there is any rhythm or unison in the sound. Dr. Gould, however, states that there is no doubt whatever that katydids keep time in their stridulations. So soon as the sun has set in North Carolina an orchestra of katydids begins to tune up. After a few preliminary raspings, the members of the orchestra begin to make their noises together; another orchestra at once answers them, and so they go on swing-swong, one set answering the other the whole night long. Mr. A. P. Bostwick adds his testimony to that of Dr. Gould as to the antiphonal rhythm of two orchestras of katydids. He has remarked that the antiphony is often very regular for several minutes, sometimes stopping short, and again becoming broken into irregular individual stridulation at the end. The exact unison of movement can hardly be purely mechanical, for the katydids often start their noises all at once. A difference of pitch between the notes of two orchestras was suspected by Dr. Gould; but Mr. Scudder, who has given much attention to the sounds made by locustarians, thinks this may have been only apparent, and due to difference in distance from the observer.

THAT real images of objects are formed upon the human retina seems to be supported by a series of experiments carried out by Mr. W. Ingles Rogers, and described by him in the *Amateur Photographer* for November 22. Mr. Rogers took a shilling and looked at it intently in ordinary daylight for a full minute, with the idea of fixing the image of it distinctly upon the retina. He then drew a yellow screen over the window of the room in which he sat, so as to exclude all actinic light, and, placing a photographic plate in a certain position, fixed his eyes upon the centre of the plate, at the same time allowing nothing but the image of the shilling to occupy his mind. He remained looking at the plate for forty-three minutes, and afterwards developed it, with the result that an outline of the coin was clearly shown upon it. The "psychogram," as the resulting picture is called, was sufficient to show that better results might confidently be expected. Accordingly, Mr. Rogers continued his experiments, and, in order that there should be no doubt about the *bonâ-fide* nature of the result, he produced a psychogram in the presence of three trustworthy witnesses, whose testimonies as to the genuineness of the photographs accompany Mr. Rogers's communication. On this occasion a postage-stamp was used instead of the coin. The stamp was looked at in a strong light for one minute. It was then removed, a plate was put in its place, and the plate was looked at for twenty minutes. The resulting psychogram is reproduced in our contemporary, and although there is an absence of detail, sufficient is seen to prove beyond doubt that a picture of an object, impressed upon the retina, can send out vibrations which will result in the production of an image upon a sensitive plate. The result is of such great interest not only to photographers, but to students of physiological optics, that we hope the experiments will be continued.

AT a recent meeting of the Paris Academy of Sciences, M. Mascart presented an interesting note on the rainfall at Athens, by M. D. Eginitis, based on observations made at the Observatory during 1878-94. The average yearly rainfall for this period was 16 inches, and the number of wet days 97·8. This amount is not very small; the reputed dryness of Athens is due to three other causes: (1) the considerable variation in the annual fall; thus in 1883 it amounted to 33·3 inches, while in 1891 it was only 8·1 inches, or half the normal value. The dry and wet years follow with some regularity; a very wet period occurs generally about every seventh year. (2) The annual range of the rainfall, which presents great irregularity. The wettest month, November, has an average fall of 3·1 inches; and the dryest, July, only 0·3 inch. From June to July the rainfall is very insignificant; at times there is none for three months. (3) The intensity; the falls being heavy, but of short duration. It rarely rains for a whole day, generally speaking, after a few hours of rainy weather the sky becomes quite clear. From observations taken at 8 a.m., 2 and 9 p.m., it is found that the amount of rainfall during the day is double what it is during the night; the maximum occurs during the afternoon, owing to the greater frequency of thunderstorms at that time. The great variation in the yearly rainfall is said to be due to the different amount of humidity brought by the equatorial air-current, according to the course it has taken in arriving at Athens.

A VALUABLE catalogue (No. 155) of choice and rare books, including selections from the libraries of the late Dr. Reginald S. Poole, and Prof. de Lacouperie, has been compiled and issued by Mr. Bernard Quaritch, 15 Piccadilly.

AT the recent meeting of the National Academy of Sciences' held at Philadelphia, the following papers were presented:—"On the Palæozoic Reptilian Order of the Cotylosauria," by Prof. E. D. Cope; "On a New Variable of Peculiar Character," by Dr. S. C. Chandler (see "Our Astronomical Column," p. 109); "On a Bone Cave at Port Kennedy, Pa," by Prof. E. D. Cope; "On Borings through the Coral Reef in Florida,' by Prof. A. Agassiz; "On the Alkali Uranates," by Prof. Wolcott Gibbs; "The Olindiadæ" and "New Campanulurian Medusæ," by Prof. W. K. Brooks; "The Filar Anemometer" and "The Counter-twisted Curl Aneroid," by Prof. Carl Barus; "On the Broadening of Spectral Lines by Temperature and Pressure," by Prof. A. A. Michelson; "On the Asteroids," by Prof. A. Hall; and "The Early Segregation of Fresh-water Types," by Dr. Theo. Gill.

THE fourth volume of *Transactions* of the Rochdale Literary and Scientific Society, covering the period 1893–1895, has reached us. Included in it are papers on "The Birds in Piethorn Valley," by Mr. W. Watts; "The Rainfall in Rochdale and the Neighbourhood," by Mr. J. R. Ashworth; "The Cold Weather at Facit, during the Winter of 1894-95," with instructive diagrams, by Mr. T. S. Smithson; and Recent Discoveries in the Manufacture of Indigo," by

Mr. W. H. Pennington. The volume represents a large amount of industry and research on the part of associates of the Society, and it will give a stimulus to the study of science in Lancashire. Another volume just published by a provincial Society is the Annual Report and *Transactions* (vol. xxix.) of the Naturalists' Field Club and Archæological Society of North Staffordshire. This volume is, as a whole, more scientific in character than that of the Rochdale Society. Reports are given of the work of the various sections of the Society concerned with observations in different branches of science, and we notice, among the other contents, an address by Dr. W. Hind; a paper on glacial theories, past and present, and their application to Staffordshire, by Mr. C. E. De Rance, and one on the occurrence of marine fossils in the coal-measures of North Staffordshire, by Mr. John Ward. Both volumes are very creditable records of the work of provincial scientific Societies.

WE have on our table several new editions of books previously reviewed in NATURE. Among these volumes is a second edition of "Modern Microscopy" (Baillière, Tindall, and Cox), a handbook for beginners, comprising a section on the microscope, and instructions for its use, by Mr. M. I. Cross; and on the preparation and mounting of microscopic objects, by Mr. Martin J. Cole. We welcome a second edition of "A Manual of Physics" by Dr. W. Peddie, bearing the same publishers' names. The work is an admirable text-book, which students of physics would do well to obtain. Messrs. Longmans, Green, and Co. have published an eighth edition of Mr. John Thornton's "Elementary Physiography"; and Messrs. Blackie and Son, the ninth edition of "Earth-Knowledge," by Mr. W. Jerome Harrison and H. Rowland Wakefield; both these books being intended for students in the physiography classes of the Department of Science and Art. Messrs. Blackie have issued also a fourth revised and enlarged edition of "Elementary Inorganic Chemistry," by Prof. A. Humboldt Sexton.

THE additions to the Zoological Society's Gardens during the past week include a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, presented by Mr. Percy A. Gore; a White-headed Sea-Eagle (*Haliaetus leucocephalus*) from Newfoundland, presented by Mr. Leicester Curzon Howe; a Chough (*Pyrhocorax graculus*), British, presented by Mr. Gerald Strickland: two Blood-breasted Pigeons (*Phlogœnas cruentata*) from the Philippine Islands, presented by Captain Harvey; two Greater Sulphur-crested Cockatoos (*Cacatua galerita*), a Crimson-winged Parrakeet (*Aprosmictus erythropterus*) from Australia, presented by Mrs. Morgan; two Barbary Wild Sheep (*Ovis tragelaphus*, ♂ ♂) from North Africa, deposited; a Great Northern Diver (*Colymbus glacialis*), twelve Snow Buntings (*Plectrophanes nivalis*), four Dunlins (*Tringa alpina*), a Golden Plover *Charadrius pluvialis*), a Grey Plover (*Squatarola helvetica*), British, a Bahama Duck (*Dafila bahamensis*) from South America, four Green-winged Doves (*Chalcophaps indica*) from India, two Bearded Vultures (*Gypætus barbatus*), European, purchased.

OUR ASTRONOMICAL COLUMN.

POSITIONS OF THE NEW COMETS.—As we go to press, the following calculated positions for the two new comets have been received from Kiel. The places are for Berlin midnight.

Perrine's Comet.

Date.		R.A. h. m. s.		Decl. ° ′
Dec. 7	...	14 52 37	...	−13 37·2

Brooks's Comet.

Date.		R.A. h. m. s.		Decl. ° ′
Dec 8	...	8 11 2	...	+44 28·2
10	...	7 45 57	...	+51 36·7
12	...	7 16 42	...	+57 23·5

SWIFT'S COMET, 1895 II.—Another comet has put in a claim to be considered the long-lost comet of Lexell; and the claim is perhaps based on a better foundation than any of the other competitors can show. Le Verrier has supported the comets of Faye and De Vico; more recently Brooks' comet of 1889 found a supporter in Dr. Chandler, but the claim was routed by the calculations of Mr. Lane Poor. M. Schulhof looked favourably for a while on the merits of Finlay, but finally inclined to the belief that the two comets had a common origin rather than absolute identity. The new comet Swift has much to recommend it to the consideration of astronomers (*Astr. Nach.*, No. 3318). In the first place, Tisserand's criterion is fairly well satisfied; next, the closest approach to the orbit of Jupiter, in the case of both comets, falls very nearly in the same longitude; further, of the various orbits along which Le Verrier showed Lexell might move, after the heavy perturbations of 1779, one can be selected which agrees very closely with the orbit of Swift. Moreover, this particular selection of the various orbits suggested by Le Verrier is supported by Clausens's work on the same comet. Here is the comparison:—

		Selected orbit of Lexell.		Orbit of Swift (Schulhof).
Long. of perihelion	...	330°·0	...	338°·1
Long. of node ...	...	169°·9	...	170°·3
Inclination ...	...	6°·0	...	3°·0
Excentricity ...	...	0·6317	...	0·6515
Semi-axis major ...	..	4·224	...	3·724
"Tisserand's criterion" ...		0·480	...	0·493
Long. of approach to ♃ ...		184°	...	179°·5

It is a question if the agreement is not too good, for the comet of Swift made a close approach to Jupiter in 1886, and underwent heavy perturbations. M. Schulhof is at present considering these; but till their character and amount is known, it is premature to decide this vexed question of identity. It is possible the question will not be set at rest till 1931, for the returns previous to that date are not very favourable for observation, and the comet may pass unnoticed. But in any case observations in large telescopes should be prosecuted as long as possible, in order to determine the mean motion with accuracy, with the view of assisting the re-discovery.

A PECULIAR VARIABLE STAR.—A variable star recently discovered by Mr. Chandler presents some very remarkable features (*Astronomical Journal*, No. 358). In the singularly short period of 5h. 31·15m., the magnitude of the star varies between 8·9 and 9·7, so that three or four of the principal phases may be observed in a single night. The variations are distinctly not of the Algol type, but maxima and minima are equally and sharply marked. The light-curve is also unlike those of the other class of short-period variables, such as δ Cephei and η Aquilæ, inasmuch as the rise to maximum and fall to minimum take place in equal periods.

The newly-discovered variable is designated U Pegasi, and its position for 1900 is R.A. 23h. 52m. 53s., Decl. 15° 23′·9; the elements of the variability are as follows:—

		G.M.T. d. h. m.	
Minimum, 1894 Sept.	...	22 14 56·0	+5h. 31m. 9·0s. E.
Maximum	...	22 17 41·6	

The probable error of the period is believed to be only a moderate fraction of a second.

It appears that Dr. Chandler discovered the variability of the star more than a year ago, but erroneously inferred that it was of the Algol type with a period of 2·06 days. Mr. Yendell confirmed the variability, and concluded that the period was 0·69d., or one-third of that assigned by Dr. Chandler; but it was still supposed to be of the Algol type. A more recent discussion of the observations, however, has established that this period must again be divided by three, and that the light-curve has the character to which reference is made above.

SATURN'S RINGS.—Some remarkable observations of the rings of Saturn are reported by A. Mascari, of the Catania Observatory (*Ast. Nach.*, 3318). Observing from July 25 to August 6 of the present year, he noticed certain dark spots on the crape ring, as well as bright ones on the brighter rings. Perhaps the most curious feature of these spots is their apparent permanence of form; for this is not easy to explain if the idea that the rings are composed of separate particles be accepted, as in that case

adjacent parts of the rings would have different angular velocities. It was found, also, that the external boundary of the outer ring apparently joined the inner bright ring at a point on its northern edge, while the crape ring was almost twice as wide in the northern as in the southern part. This imperfect symmetry of the outer ring and crape ring with the inner bright ring, suggests that they do not all rotate in one plane. The different divisions of the ring would thus cast shadows upon each other, the amount of shadow depending upon the inclination.

The colour of the crape ring is described as bluish, and the shadow of the globe on the rings was curved, with the convexity towards the planet. Encke's division was very feeble and uncertain during the observations. It is pointed out that future observations of the spots may throw further light upon the rotation and constitution of the rings.

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

LAST Saturday being St. Andrew's Day, the Anniversary Meeting of the Royal Society was held in their apartments at Burlington House. The auditors of the Treasurer's accounts having read their report, the Secretary read the list of Fellows elected and deceased since the last Anniversary.

The qualifications of the new Fellows were given in NATURE of May 9 (vol. 52, p. 31). Since the last Anniversary Meeting, the Society has lost nineteen Fellows and seven Foreign Members, viz. :—

Bisset Hawkins, December 7, 1894, aged 98.
Pafnutij Tchebitchef, December 8, 1894, aged 73.
Arthur Cayley, January 26, 1895, aged 73.
Sir James Cockle, January 27, 1895, aged 76.
Rev. Thomas Penyngton Kirkman, February, 1895, aged 88.
John Whitaker Hulke, February 19, 1895, aged 64.
Henry Austin Bruce, Lord Aberdare, February 25, 1895, aged 80.
Sir William Scovell Savory, March 4, 1895, aged 69.
Sir Henry Creswicke Rawlinson, March 5, 1895, aged 84.
Albert William Beetham, March 11, 1895, aged 95.
James Dwight Dana, April 15, 1895, aged 82.
Carl Ludwig, April 24, 1895, aged 78.
Roundell Palmer, Earl of Selborne, May 4, 1895, aged 83.
Henry John Carter, May 4, 1895, aged 82.
Sir George Buchanan, May 5, 1895, aged 64.
Franz Ernst Neumann, May 23, 1895, aged 97.
Valentine Ball, June 15, 1895, aged 52.
William Crawford Williamson, June 23, 1895, aged 78.
Right Hon. Thomas Henry Huxley, June 29, 1895, aged 70.
Henri Ernest Baillon, July 19, 1895, aged 67.
Charles Cardale Babington, July 22, 1895, aged 86.
Sir John Tomes, July 29, 1895, aged 80.
John Syer Bristowe, August 20, 1895, aged 68.
Sven Ludwig Lovén, September 3, 1895, aged 86.
Louis Pasteur, September 28, 1895, aged 73.
George Edward Dobson, November 26, 1895, aged 47.

Lord Kelvin, the President, then delivered the Anniversary Address as follows :—

In Cayley we have lost one of the makers of mathematics, a poet in the true sense of the word, who made real for the world the ideas which his ever fertile imagination created for himself. He was the Senior Wrangler of my freshman's year at Cambridge, and I well remember to this day the admiration and awe with which, before the end of my first term just fifty-four years ago, I had learned to regard his mathematical powers. When a little later I attained to the honour of knowing him personally, the awe was evaporated by the sunshine of his genial kindness; the admiration has remained unabated to this day, and his friendship has been one of the valued possessions of my life. While we mourn his departure from among us we know with gratitude that he has left an imperishable monument of his life's work in the grand edition of his mathematical writings which the University Press of Cambridge gives to the world. The interesting and genuinely appreciative obituary notice of Arthur Cayley, contributed by our colleague, Prof. Forsyth, to the *Proceedings* of the Royal Society for the present year, has been reprinted as a preface to the eighth volume of his "Collected Mathematical Papers," which was published last August, rather more than half of it having been passed through the press by the author with notes and references, and the remainder simply reprinted from the original publications. Matter for two more such volumes remains to be reprinted.

At the good old age of ninety-seven the veteran Franz Ernst Neumann has left us. He has been one of the most profound and fertile of all the workers in mathematical physics of the nineteenth century. I remember with gratitude the admirable and suggestive theorem[1] on electromagnetic induction which I learned in 1848, from a first paper on the subject which he had communicated to the Berlin Academy of Sciences, and which, translated into French, was published in the April number of that year of Liouville's *Journal des Mathématiques*. That first paper and others which followed it on the same subject, and his papers on the physical theory of light and on elasticity, are grand and permanently valuable contributions to science.

The death of Huxley, one of my predecessors in the Presidential chair of the Royal Society, takes from us a man who can ill be spared. During the fifty years since he sailed from England, as assistant-surgeon on board H.M.S. *Rattlesnake*, bound for a surveying expedition in the southern seas, he had been a resolute and untiring searcher after truth, and an enthusiastically devoted teacher of what he learned from others and what he discovered by his own work in biological science. His first contribution to science was a short note communicated, while he was still a student in the Charing Cross Hospital, to the *Medical Times and Gazette*, describing a structure in the root-sheath of hair, which has since borne the name of Huxley's layer. It was followed by papers on the blood corpuscles of the *Amphioxus lanceolatus* and on the anatomy and affinities of the family of *Medusæ*, for the British Association and the Royal Society; and several other articles on various biological subjects, all describing some of the work of the leisure left him by his medical duties during his four years' cruise on board the *Rattlesnake*, which were sent home by him to England, and published during his absence. It is to be hoped that the long series, thus so well begun, of papers describing skilful and laborious research by which knowledge was increased in every department of biology, will be given to the world in collected form as soon as possible. Even those purely scientific papers contain ample evidence that Huxley's mind did not rest with the mere recording of results discovered by observation and experiment: in them, and in the nine volumes of collected essays which he has left us, we find everywhere traces of acute and profound philosophic thought. When he introduced the word agnostic to describe his own feeling with reference to the origin and continuance of life, he confessed himself to be in the presence of mysteries on which science had not been strong enough to enlighten us; and he chose the word wisely and well. It is a word which, even though negative in character, may be helpful to all philosophers and theologians. If religion means strenuousness in doing right and trying to do right, who has earned the title of a religious man better than Huxley?

Another name literally of world-wide fame, Louis Pasteur, stands next to the end of our list of losses. Before he entered on his grand biological work, Pasteur made a discovery of first-rate importance in physics and chemistry—the formation of crystals, visibly right-handed and left-handed, from a solution of racemate of soda and ammonia; and the extraction of ordinary tartaric acid and of a kind of tartaric acid not previously known, from solutions obtained by picking out the crystals separately and redissolving: the new kind of tartaric acid having the property of producing the opposite rotatory effect on the plane of polarisation of light to that produced by ordinary tartaric acid From 1848 to 1857 he was chiefly occupied with researches related to the subject of that great discovery, as may be seen from the titles of the first twenty-two of his papers in the Royal Society Catalogue. His work of those nine years led up from Biot's fundamental discovery of the dioptric heliçoidal property of liquids and vapours, to the enrichment of chemistry by the annexation of a new province called stereochemistry, splendidly and fruitfully developed twenty years later by Le Bel and Van 't Hoff. Near the end of 1857 his twenty-third paper appeared, three pages, in the *Comptes rendus*, "Sur la Fermentation appelée lactique." It shows that he had then entered on the

[1] Quoted in "Mathematical and Physical Papers" (Sir William Thomson), p. 92, vol. i.

line of research to which he devoted the rest of his life, and by which he conferred untold benefits on humanity and the lower animals. As I had occasion to remark in my Presidential Address of last year, Helmholtz had in his earliest work proved almost to a certainty "that the actual presence of a living creature—vibrio, as he called it, bacterium as we more commonly call it now—is necessary for either fermentation or putrefaction." Pasteur gave complete demonstration of that conclusion, and early expanded it to vast and previously undreamt of extensions of its application. The first great practical application of his views was made by Lister about 1863-65, then my colleague in the University of Glasgow, now recommended by your Council as my successor to the Presidency of the Royal Society. From Pasteur's discoveries he was led to work out the principles of his antiseptic surgery, the practice of which he commenced in the Glasgow Royal Infirmary in the summer of 1865.

Having been led to trace microbes as the origin not only of fermentation and putrefaction, but of a vast array of destructive blights happening to plants and animals—vines, silkworms, birds, cattle, and mankind—Pasteur was forced to take up the question, as of supreme practical importance, "Whence came these microbes, and what are their antecedents?" From warmth and moisture, as we see by turning up a stone in a field, I was told forty years ago by an Arran farmer well versed in the popular literature of the day. We are sometimes told the same thing in scientific journals of 1895 under the more learned disguise perhaps of abiogenesis, or the fortuitous concourse of atoms, not tested by the calculus of probabilities. Without wasting words to prove theoretically that, while stones falling together may, as we all believe they have actually done, make a solar system with a habitable planet or planets, they cannot make a man, or a microbe, or an organic cell with its property of heredity, Pasteur set about practically to trace the antecedents of every microbe he met with, and he found for it in every case a living thing, whether in the air, or in water, or in earth. During nearly all the latter part of his life and to the end Pasteur devoted himself to biological research, and to vigorous practical realisation of its benefits for the world.

Turning now to the business of the Royal Society since our last Anniversary Meeting, I am glad to be able to report that excellent progress has been made with the "Catalogue of Scientific Papers." Vol. xi. of the Catalogue, under authors' names, completing the alphabet, is on the eve of issue, and the supplementary volume is far advanced.

The movement which led to the inception of the Catalogue dates back forty years—to the first meeting of the British Association in Glasgow, when Prof. Henry, of Washington, communicated a proposal for the publication of a catalogue of philosophical memoirs scattered throughout the Transactions of Societies in Europe and America, with the offer of co-operation on the part of the Smithsonian Institution.

The proposal was referred to a committee consisting of Mr. Cayley, Mr. Grant, and Mr. Gabriel Stokes. The year after, at the Cheltenham meeting, this committee propounded a scheme for a Catalogue, embracing the mathematical and physical sciences, to include both authors' names and subjects. Besides, Transactions and Proceedings of Societies, journals, ephemerides, volumes of observations, and other collections not coming under these heads were to be indexed.

This scheme came before the Royal Society in March 1857, in consequence of a request made by General Sabine at the instance of the British Association. Considerable discussion took place, and eventually it was decided to prepare a *manuscript* Catalogue of periodical works in the Royal Society's library, to include all the sciences, the question of printing being deferred; and to do the work at the Society's sole charge. Subsequently it was resolved to extend the Catalogue to works in other libraries not included in that of the Royal Society.

In 1864 it was decided to offer the Catalogue to Government for publication, and in 1866 the printing of the first series of the Catalogue, covering the period from 1800 to 1863, was commenced by the Stationery Office. The sixth and last volume of the series was published in 1872. Two additional volumes, covering the period 1863-1873, were published in 1879. The Treasury then declined to continue the publication of the Catalogue, which, however, was undertaken by the Society, assisted by a sum of £1000 voted by Parliament towards the charges of publication of the decade 1873-1883. The unexpended portion of this grant was invested in a policy, under which £1000 will become available for the purposes of the Catalogue in October, 1899.

So far back as June, 1864, it was resolved by the Council that the Catalogue according to authors should be followed by the immediate publication of an Index according to subjects. Such an Index Rerum was constantly under consideration, and many plans for its preparation have been discussed. The work at last took practical shape in 1893, when our Fellow Mr. Ludwig Mond most generously presented a sum of £2000 to the Society, in aid of the work of preparing the Catalogue and the Subject Index. Out of this liberal donation there remains unexpended a sum of £1500. A special staff was organised, by whom more than 140,000 slips have now been mounted and arranged in boxes, and of these over 46,000 have already been provisionally prepared for press. Since the last Anniversary, the department has to some extent been reorganised by the Committee, women being now employed in the Index Rerum Department, and Miss Chambers having been entrusted with full control over the whole. The total number of women employed in the two departments including junior copyists is now twelve.

It has, however, long been felt that the continuation of such a work was almost beyond the resources of the Royal Society, and therefore about two years ago a committee was appointed to take into consideration a suggestion that the preparation of complete indexes to scientific publications should be effected by international co-operation.

This very important subject has continued to engage the attention of the Council during the past year; and the suggestion of international co-operation having been recommended to Her Majesty's Government for favourable consideration, official invitations have been issued to an International Conference to be held in London in July next.

Meanwhile others have been equally aware of the great importance attaching to the indexing of literature, and only in September last an International Institute of Bibliography was established by Royal Decree in Brussels.

Two gentlemen in that city, MM. Otlet and La Fontaine, have, during the past half-dozen years, devoted themselves to the study of modern methods of bibliographic classification, specially with reference to sociology, and their work has been supported by the Belgian Government. They were led to adopt the decimal system devised by Melvil Dewey, which is popular with American librarians, and having made a careful study of its application, have become so impressed with its value that they have developed an extraordinarily comprehensive scheme applicable to literature generally.

An invitation to attend a conference in Brussels at the beginning of September last was received by the Royal Society early in August, too late unfortunately to permit of a representative being present.

At the conference held there on September 2 to 4, a number of resolutions to establish an International Institute of Bibliography as a development of the work begun by the above-mentioned gentlemen, were arrived at, and by a Royal Decree of September 12, 1895, such an office was established.

Your senior Secretary had an opportunity, when in Brussels recently, of visiting the office which has been established, and of seeing the skill and zeal with which the preliminary preparations have been made to carry the work into execution.

All must admire the energy and enterprise which has thus been displayed in Belgium. At the same time, the magnitude of the work and the importance of the interests involved are such that it appears most desirable that the action which the Royal Society has already taken for an International Conference should be persevered in, so that decisions may be arrived at which may ensure, if possible, complete success. The enterprise is one in which we, in consequence of our long connection with such work, are most deeply interested; it is also one which may well become of exceeding value to science generally. But it is impossible to overrate the difficulties connected with it; and to avoid unnecessary complications in the future it is essential that very many questions—especially the division of the subject matter in the various branches of science and the nomenclature to be used—be taken into consideration by competent bodies and settled by general agreement.

In my last Anniversary Address I mentioned that the Library Committee, in view of the great accumulation of the stock of *Philosophical Transactions*, were taking measures to make the memoirs composing the volumes separately available to the public, which, while facilitating the sale, would increase their

utility. I have now the pleasure to announce that arrangements have been made with Messrs. Dulau and Co. to carry out this suggestion, and that Messrs. Dulau have, at their own expense, issued a very useful alphabetical list of all the papers in the *Philosophical Transactions*, from the year 1800 to the present time, any of which may now be separately purchased by the public.

The great and increasing success of our annual soirées has led the House and Soirée Committee to recommend to the Council that in addition to the two conversaziones held in May and June, some informal receptions for the Fellows should also be occasionally held. This suggestion was readily adopted by the Council, and the first of these receptions was held last month.

The Water Research Committee have continued the labours which they commenced in conjunction with the London County Council four years ago, and although the County Council no longer contributes to the expenses, the Committee have been able to carry on the researches, partly by means of an assignment from the Government grant, and partly by a grant from the fund established in 1891, by his Excellency Dr. Gunning. A Report, of 200 pages, by Prof. Marshall Ward, forming the Fourth Report to the Committee, was presented to the Council of the Royal Society last March, and has been published in the *Proceedings*. This Report treats on the biology of *Bacillus ramosus* (Fraenkel), a schizomycete of the River Thames.

With respect to the Gunning Fund which I have just now mentioned, the Committee appointed by the Council to consider and report upon the best terms for carrying out the trust, made the following recommendations, which, with Dr. Gunning's approval, were adopted by the Council:—

"(1) That the Fund should not be applied in the form of a prize, medal, or reward, but should be devoted to the furtherance of knowledge in some special direction.

"(2) That, by preference, the interest accruing from the Fund during every three years be applied for the promotion of Physical Science and of Biology alternately.

"(3) That aid should, by preference, thus be given in Physical Science and Biology respectively, either to investigations or operations which require to be repeated from time to time, or to the development of some specified continued line of research."

The Council, while adhering to the policy of retrenchment touched upon in my last address, have had to recognise the fact that the Society was, at that time, already committed to a large amount of publication, a great bulk of printed matter being almost ready for issue. This accumulation has been rapidly worked off during the past session, with the result that the Council, notwithstanding that every effort has been made to limit the amount of fresh publication, have issued in the mathematical and physical section of the *Philosophical Transactions* no less than thirty-one papers, and in the biological section twenty-one. The two sections together contain in all 2259 pages of letterpress and sixty-one plates. Of the *Proceedings*, fourteen numbers have been issued, containing 1356 pages.

While determined not to depart from the policy of avoiding all unnecessary expenditure on publication, the Council felt that with only the funds hitherto at its disposal it could not effect the requisite diminution of expenditure without diminishing the efficiency of the Royal Society in promoting the augmentation of natural knowledge, which is the reason for its existence. An application to the Treasury for additional funds was therefore made by a resolution of Council adopted at its meeting of June 20 last. I am happy to say that a favourable answer has been received, and a grant of £1000 a year has been given by the Treasury to the Royal Society on the purpose of aiding in the adequate publication of scientific matter, whether in the *Transactions* or *Proceedings* of the Society or through other channels and in other ways.

At a meeting of the Council on October 17 it was resolved to send to the Institute of France the following address on the occasion of the centenary of its foundation; and it was agreed to authorise the President and Treasurer to represent the Royal Society at the commemoration to be held in Paris from October 23 to 26:—

"The President and Council of the Royal Society of London offer to the Institut de France their most cordial congratulations on the auspicious occasion of the centenary of its existence, which it is now about to celebrate.

"The President and Council are well aware that various ancient Academies flourished in France long before the official foundation of the Institùt as a means of recording discoveries and promoting arts and sciences, and that much of that great advance in human knowledge which took place during the 17th and 18th centuries was due to the labours of members of the French Academy of Science.

"The foundation of the Institut, however, comprising as it does five Academies, each with its own special sphere of action, but all united as one harmonious whole, constantly investigating the laws of nature and the developments of art, constitutes an era in the history of civilisation.

"It would be an endless task to attempt to enumerate the branches of human knowledge which during the past century have benefited by the labours of the Institut. It is a body of which not only France but the whole of the civilised world may be justly proud.

"It is sad to think, that just at the moment of a commemoration which would otherwise have been celebrated with unalloyed pleasure, Science has to mourn the loss of one of her most distinguished votaries. The single-minded and devoted labours of Pasteur, and their beneficial results to man and the domestic animals, are recognised throughout the whole world with the highest gratitude and admiration. The Royal Society assures the members of the Institut of its hearty sympathy in the sad loss that they and humanity at large have sustained.

"That the Institut may long continue to exist and prosper, and that each succeeding century may witness an ample harvest from its labours, is the heartfelt wish of the President and Council of the Royal Society.

(Signed) "KELVIN,
"*Pres. R.S.*"

I had the honour of presenting this address to the President of the Institute of France in person. For myself and other Fellows of the Royal Society who were present along with me I may be allowed to say that we were much gratified with the friendly and fraternal reception accorded to us, as colleagues and fellow labourers in the work of the Institute.

I am sorry to say that we are now losing the service, as Assistant-Secretary, of Mr. Herbert Rix, who, after seventeen years of faithful work for the Royal Society, retires from this post, as he finds the necessarily increased anxiety and burden of the office to be too great a strain upon his health. We all feel grateful to him for the manner in which he has discharged his duties from the time he first entered the service of the Royal Society; and I am sure the Fellows generally will agree with the Council in being pleased that we have been able to arrange to still have Mr. Rix to help us in our work, in the less arduous post of Secretary to the Government Grant Committee.

A very important scientific event of the past year, resulting from work initiated by the Royal Society a quarter of a century ago, is the completion of the "Report of the *Challenger* Expedition," in fifty large royal quarto volumes containing 29,500 pages, and illustrated by over 3000 lithographic plates, copper-plates, charts, maps, and diagrams. I may remind you that H.M.S. *Challenger* was fitted out by the Government in 1872, on the recommendation of the Royal Society, and was absent for nearly four years on an exploration of the Great Ocean Basins. The publication of the numerous observations, which have enriched almost every branch of science, was at first carried on under the direction of Sir C. Wyville Thomson, and subsequently by Mr. John Murray.

I have been myself much struck with the extreme beauty of many of the plates contained in these volumes; and, though no expert in the subject, I may be allowed to say that I believe nothing more admirable has been hitherto given to the world in the way of illustration and representation of biological subjects. Of the maps, I may confidently say that they are models of careful, accurate, and elaborate work. Two volumes of the Report deal with the narrative of the voyage, three volumes with the physics and chemistry of the ocean, one volume with deap-sea deposits and geology, two volumes with botany, forty volumes with marine zoology, and two volumes are devoted to a summary of the scientific results.

How highly the work of the *Challenger* expedition is appreciated by those best qualified to judge of the merits of its results is illustrated by the following words, spoken by Milne-Edwards at a meeting of the International Congress of Zoology, held last September in Leiden:—L'expédition du *Challenger* a porté des fruits merveilleux. Ceux qui l'ont organisé, ceux qui y ont pris part, et dont quelques-uns ne sont plus ici pour

recueillir le prix de leurs efforts, ceux qui en ont étudié les résultats, ont rendu des services dont nous leur sommes profondément reconnaissants. Le monument scientifique ainsi élevé par les savants anglais constitue un titre de gloire dont une nation a le droit d'être fière."

The contributors to this gigantic Report are, for the most part, natives of the United Kingdom and the British Colonies, but the scientific men of nearly every civilised State are represented among the authors. The British and foreign contributors are seventy-six in number, and many scientific men whose names do not appear on the title-pages of the special memoirs have taken part in the physical and chemical researches performed in connection with the work of the expedition. Among the contributors we find the names of Alexander Agassiz, Ernst Haeckel, P. G. Tait, G. O. Sars, F. E. Schulze, T. H. Huxley, Rudolph Bergh, A. v. Kölliker, A. Renard, W. K. Brooks, N. N. Polejeff, Th. Studer, A. A. W. Hubrecht, W. Dittmar, Sir William Turner, A. Günther. Before the end of the present meeting I shall have the pleasure of presenting to Mr. Murray one of the Royal medals, which has been awarded to him by the Council of the Royal Society, to mark their appreciation of his editorship of this great work, and of his own scientific contributions to it.

In my Presidential Address of last year I took occasion to refer to Lord Rayleigh's discovery that the gas which remains when oxygen, vapour of water, and carbonic acid are removed from common air, is denser than nitrogen extracted from chemical compounds; and I was then able to tell you of the consequent discovery that our atmosphere contains a fifth constituent which is denser than nitrogen. This discovery had been thoroughly established by Rayleigh, in association with Ramsay, who had joined him in the work; but no details had then been published. They had succeeded in isolating the new constituent by extracting all the four previously known constituents (oxygen, nitrogen, aqueous vapour, carbonic acid) from air, and they were energetically at work with a view to discovering its properties. I concluded my last year's Address by expressing the hope that their work would give us, "before the next Anniversary Meeting of the Royal Society, much knowledge of the properties, both physical and chemical, of the hitherto unknown and still anonymous fifth constituent of our atmosphere." That hope, as you all know, has been splendidly fulfilled. They early discovered a name for it, Argon, because exhaustive chemical investigation gave them no evidence of its chemical combination with any other known element. They found its density to be very high, 20 (that of oxygen being called 16), and the ratio of its specific heats $1\frac{2}{3}$. Olzewski, experimenting on a specimen sent to him by Ramsay, succeeded in liquefying it, and found its critical pressure to be 50·6 atmospheres, and its critical temperature $-121°$. These results were communicated in a joint paper by Rayleigh and Ramsay to the Royal Society at a memorable meeting, held in the theatre of the University of London, because our ordinary meeting-room was not large enough to contain all who wished to hear it. It will be gratifying to Fellows of the Royal Society to know that the Smithsonian Institution of Washington gave to Lord Rayleigh and Prof. William Ramsay the first Hodgkins' prize for their "Memoir on Argon: a New Constituent of the Atmosphere." This memoir had been communicated to Washington before the end of December 1894.

Since the dates of those first communications much work has been done by various observers on the spectrum analysis of argon. In a communication by Rayleigh to the recent meeting of the British Association, we find a very accurate determination of its refractive index and its viscosity. Ramsay, in trying for clues to compounds of argon, had his attention called by Mr. Miers (of the British Museum) to a paper by Hillebrande, telling that cleveite (a rare Norwegian mineral which consists chiefly of uranate of lead) gives out 2 per cent. of gas, supposed to be nitrogen, when warmed with weak sulphuric acid. Ramsay, thinking the so-called nitrogen might turn out to be argon, experimented on the mineral. He found that the gas evolved, by heating it in sulphuric acid, contained a trace of nitrogen, which he removed by the Cavendish process of sparking with oxygen in presence of alkaline liquor. The residue was proved by the spectrum test to contain argon, but to contain also another gas, not argon, showing itself by a brilliant yellow line. This line was identified by Crookes as the "helium line," discovered thirty years ago by Lockyer, who, finding it to have been not discovered in the spectrum of any terrestrial substance spectroscopically examined up to that time, attributed it to a substance in the sun's atmosphere, which he called helium. Thus, a substance, discovered thirty years ago in the sun's atmosphere, and accordingly named from the sun, has been found in a terrestrial mineral by Ramsay, in his quest after argon. Having got helium into his laboratory, he found its density to be less than 3·9 (ultimately reduced to 2), and, therefore, less than one-fifth (about one-tenth) of that of argon. He sent a specimen to Olzewski, who found (NATURE, October 3, 1895) that the treatment by which he had succeeded in liquefying hydrogen—namely, compressing with a pressure of 140 atmospheres, cooling to the temperature of liquid air boiling at low pressure, and then expanding suddenly, showed no signs of liquefying helium.

Considering the uncertainty as to the density of the gas in which helium was identified, and the multiplicity of spectrums found for it by various experimenters, Lockyer, who experimented on some eighty minerals, and found the yellow line of helium in sixteen of them, thinks it most probable that it is not a single gas that is extracted either from cleveite or the other minerals, but a mixture of gases of which helium is one; and this view was supported by Runge and Paschen in their admirable spectroscopic analysis of argon and helium, communicated to the British Association ("British Association Report," Section A, September 18, 1895) at its recent meeting at Ipswich. It seems too early to feel sure that the helium found by Ramsay in the gas from cleveite, if perfectly purified of nitrogen and other known gases, is a single gas, or is a mixture or combination of several. Before another Anniversary Meeting of the Royal Society, it is probable that we shall have certain knowledge, without any doubt, as to this question. Meantime, at our present Anniversary, we may be satisfied to feel that if there are several new gases, of which one, at least, has density less than a quarter of that of oxygen, the discovery will be several times as interesting as if the helium now discovered proves to be only one gas.

COPLEY MEDAL.

Dr. Karl Weierstrass, For. Mem. R.S.

Dr. Karl Weierstrass is distinguished for his investigations in pure mathematics, extending over a period of fifty years. He is one of the great pure mathematicians of the century.

Among his researches, dealing with many branches of the science in which his work is of significant effect, may be specially mentioned :—

(i.) His investigations in pure algebra, particularly in relation to functions of real variables, to the considerations of convergence and divergence of series and products, and to the theory of bilinear and quadratic forms.

(ii.) His contributions to the general theory of functions of complex variables. This subject he has developed from its foundations, and has re-established it on a new basis, so that much of it is his creation. The extensions which he has made to this theory have of themselves proved sufficient to secure for him the distinction of an acknowledged master.

(iii.) His work in the theory of periodic functions. In particular, the advances made by him in the theory of Abelian transcendents, mark the chief algebraical development since the time of Abel and Jacobi, and they have stimulated others to further developments. Also the valuable advances made by him in the theory of elliptic functions have been fruitful and suggestive as the starting-points for researches by a number of distinguished mathematicians.

(iv.) His work in the calculus of variations, the best known published part of which relates to the theory of minimal surfaces.

Not least remarkable among his claims to originality is the method of proof which he has introduced in his investigations; he has associated a vigour and a strictness with the minutest details of his proofs that have not merely led to the sound establishment of propositions, but have indicated limitations and have suggested new ideas.

ROYAL MEDAL.

Dr. John Murray.

To Dr. John Murray one of the Royal Medals is awarded for his energetic and successful editorship of the Report of the *Challenger* Expedition, and for his own large contributions to the work of the expedition and to the scientific papers embodied in the Report. In this matter Dr. Murray's labours are recognised universally as having been of extreme value to zoological science. His own contributions to the elucidation of the material brought home by the *Challenger* have been of great

importance and originality. His researches on the deep sea deposits, and his general discussion of the oceanographic results of the expedition, are recognised as being of first-rate quality.

Dr. John Murray has already received the "Prix Cuvier" of the French Académie des Sciences, and it is right that the corresponding body in this country should take the first opportunity available to it, after the completion of the *Challenger* Reports, to express its appreciation of their value.

ROYAL MEDAL.

Prof. James Alfred Ewing, F.R.S.

A Royal Medal is conferred on Prof. J. A. Ewing for his investigations on magnetic induction in iron and other metals.

The magnetic properties of iron and steel when subjected to magnetising forces of different intensities, under various conditions of temperature and mechanical stress, have been studied by many physicists both in this country and abroad. In a series of papers which have appeared at intervals during the last fourteen years, Prof. Ewing has put on record a remarkable collection of experimental facts connected with these complicated subjects. In some of his results and methods he was anticipated by others, but apart from the wide extent of his investigations, he has displayed great sagacity and originality both in his more fundamental researches, and in the directions in which he has developed his work.

Having studied the behaviour of iron when subject to magnetic forces which vary in a cycle, he applied the same process to nickel, proving that, as in the case of iron, the susceptibility is constant for small forces, but that the range of force over which this law holds good is much larger for nickel than for iron.

Prof. Ewing has also investigated the behaviour of iron and steel of various qualities, of manganese steel, of cobalt and nickel, when placed in very strong magnetic fields, the intensity of which was raised to the splendid magnitude of 46,000 C.G.S. units in the air around the metal bar under observation. He thus showed experimentally, in corroboration and extension of Joule's primary discovery, that the intensity of magnetisation approaches asymptotically towards a limiting value, which it very nearly reaches before the magnetising force attains a comparatively small magnitude, and at which it remains constant while the magnetising force is increased without limit.

Not content with investigations such as these, Prof. Ewing has made an important advance in our knowledge of the probable constitution of magnetic substances. He constructed a model of such bodies by placing a number of small magnets near to each other so that each is free to rotate in a horizontal plane. These magnets, when disturbed, settled down into groups of more or less stable equilibrium, which are gradually broken up under the influence of increasing magnetic forces. This model suggests the novel and most important conclusion that the act of magnetisation is accompanied by the re-arrangement of similar groups of magnetic molecules. So closely does it reproduce the behaviour of iron, that it is possible not only to imitate the more prominent phenomena, to copy the curve of magnetisation, and the loops produced by cyclic forces, but also to detect minor details which were for long overlooked in iron itself.

Throughout these theoretical researches Prof. Ewing has paid attention to their practical applications. The well-known phenomenon which he has named "hysteresis" plays an important part in the action of transformers. He has, on this account, invented two instruments by which the magnetic properties of samples of iron can be readily tested.

Prof. Ewing's researches on magnetic induction are described in a series of memoirs published in the *Transactions* of the Royal Society, and in a number of shorter papers which appeared chiefly in the *Roy. Soc. Proc.* and the "Reports of the British Association." He ranks as one of the principal authorities on a subject of great theoretical and practical importance. He has thrown light upon the theory, and has facilitated its application to industry.

DAVY MEDAL.

Prof. William Ramsay, F.R.S.

Prof. Ramsay's earlier researches were in the department of organic chemistry. Nearly twenty years ago he was carrying on researches on picoline and its derivatives, which were published in the *Phil. Mag.* for 1887 and 1888, and on quinine and its decomposition products, the results of which were published in the *Chem. Soc. Trans.* for 1878 and 1879.

Prof. Ramsay's later researches have been more devoted to subjects in the borderland dividing chemistry and physics. In 1879 and 1881, he published in the *Chem. Soc. Trans.* four papers on molecular volumes, and between the years 1880 and 1892 he communicated to the Royal Society eight papers on the critical state and properties of liquids, two being published in the *Proceedings*, and six in the *Phil. Trans.* In 1893 he published the results of researches on molecular surface energy in the *Phil. Mag.*, the *Chem. Soc. Trans.*, and the *Proc. Roy. Soc.* In 1893 he communicated to the *Phil. Mag.* a very important paper on the expansion of rarefied gases.

But the researches on which the award of the Davy Medal to Prof. Ramsay is chiefly founded are, firstly, those which he has carried on, in conjunction with Lord Rayleigh, in the investigation of the properties of argon, and in the discovery of improved and rapid methods of getting it from the atmosphere; and, secondly, his discovery in certain rare minerals of a new elementary gas which appears to be identical with the hitherto hypothetical solar element, to which Mr. Lockyer many years ago gave the name of "helium." The spectrum of this terrestrial gas was seen at first as an extremely narrow and sharp line of a brilliant yellow colour, close to, and slightly more refrangible than, the sodium lines D_1 and D_2, and having a wave-length near to 5876, this, according to recent determinations, being the wave-length of the solar line of helium, or, as it is usually designated, D_3. Shortly after its discovery, Prof. Runge, of Hanover, announced that the yellow line of Ramsay's gas was double, consisting of a strong component having a wave-length of 5875·88, and a faint component having a wave-length of 5876·21. As no observer had seen the solar line, D_3, double doubt was thrown on the first assumption that Prof. Ramsay had actually isolated a solar element hitherto unknown on the earth. Within the last few weeks, however, Dr. Huggins, in England, and Prof. Hale, in America, have detected the presence of a faint luminous companion of D_3 in the spectrum of the chromosphere, and as these solar lines have the same wave-lengths as those of the corresponding terrestrial lines, the doubts at first raised have been set at rest. The body giving rise to the solar line D_3, and Prof. Ramsay's new gas from cleveite, uraninite, bröggerite, monazite, and many other rare minerals, is now admitted by chemists, physicists, and astronomers to be the same substance—helium.

The conferring of the Davy Medal on Prof. Ramsay is a crowning act of recognition of his work on argon and helium, which has already been recognised as worthy of honour by scientific societies in other countries. For his discoveries on these gases he has already been awarded the Foreign Membership of the Société Philosophique de Genève, and of the Leyden Philosophical Society. He has had the Barnard Medal of the Columbia College awarded to him by the American Academy of Sciences, and within the last few weeks he has been elected a Foreign Correspondent of the French Académie des Sciences.

Five years have now passed since you elected me to be your President. Living at a distance of 400 miles from London, I felt that it could not be possible for me to accept the honour when the possibility of its being offered to me was first suggested. I accepted, with much misgiving as to my ability to perform the duty which would fall upon me; and now, after having been re-elected four times, I feel that if the interests of the Society have not suffered under my Presidency, it is chiefly because they have been so faithfully and unintermittently cared for and worked for by the other officers, the Treasurer and the Secretaries, who have left nothing undone that could be done to promote the welfare of the Royal Society. For their unfailing kindness to myself I can only offer my heartfelt thanks. I soon found that what I looked forward to with apprehension—the Council meetings, and as many of the ordinary meetings as I could attend, during my University session in Glasgow—were the reverse of fatiguing; and I am only sorry that I have been so many times obliged to forego the pleasure of performing that part of my Presidential duty. I look back otherwise with unmixed pleasure to all the meetings at which I have presided, and my sole regret now is—I cannot disguise it, and it is a very keen regret—that these five years are passed, and that to-day I cease to be your President. I thank you all, my colleagues of the Royal Society, for electing me five times to be your President, for

forgiving me all my short-comings, and for the inestimable benefit which you have conferred on me by giving me your friendship.

In the evening a large number of the Fellows and their guests dined together at the Hôtel Métropole. Among those present being M. Marey, who attended officially as President of the Paris Academy of Sciences.

DR. DUBOIS' "MISSING LINK."

THE opening scientific meeting of the session of the Royal Dublin Society, on November 20, was of especial interest, owing to the presence of Dr. Eugene Dubois, who exhibited the famous remains which he discovered in Java. The chair was taken by Prof. W. J. Sollas, F.R.S. Dr. Dubois read a paper "On *Pithecanthropus erectus*: a transitional form between Man and the Apes," which will very shortly be published by the Society, and which was illustrated by a number of lantern slides made in Dublin for this lecture. He said that when he was invited by Prof. Cunningham to read a paper before the Royal Dublin Society, he did not for a moment hesitate to comply, as he was anxious to get as much criticism as possible. By order of the Dutch Indian Government he conducted, from 1890 to 1895, explorations of a fossil vertebrate fauna, of which some remains had been discovered many years ago by Junghuhn and others. These vertebrate remains, which were found abundantly at Trinil on the southern slope of the low Kendeng Hills, were obtained from beds of cemented volcanic tuff, consisting of clay, sand and consolidated lapilli, which were rearranged by fluviatile action. The whole formation attains a maximum thickness of over 350 metres. In these strata the Bengawan River has cut its channel 12 to 15 metres in depth. These beds lie unconformably upon beds of marine marl, sand and limestone, which have recently been determined by Prof. Martin to be of Pliocene age. In August 1891, Dr. Dubois came upon a very rich layer of fossil bones, in which the remains in question were found; this occurred in the lapilli deposit, or fine gravel, about five inches above a bed of coarse gravel, which rests on a black clay. The layer of bones lies a little below the dry-season level of the river. The river-bank was excavated with such care that the position of each specimen was accurately known. In September a wisdom tooth was discovered, and a month later the skull-cap was found about one metre distant, and at precisely the same level. The work was interrupted by the rainy season, but was renewed in May 1892; the left femur was found in August, at distance of about 15 metres from the calvaria, and in October a second molar, at a distance of 3 metres from where the skull-cap was found, and in a direction towards the place where the femur had been dug out. Among the associated animals may be mentioned large numbers of Stegodon, specimens of hippopotamus (Hexaprotodon), hyæna, several species of deer, Bubulus, a gigantic pangolin three times as large as the existing Javan form, &c. The four remains were all in the same state of fossilisation as the animal remains, the weight of the femur being nearly three times that of a recent femur. Doubt had been expressed whether the four remains belonged to the same individual; Dr. Dubois himself had no doubt on this point, as he had often found bones from the self-same skeleton, and even fragments of a single bone, at similar distances apart; never had he found a complete skeleton. He had good reasons for believing that the animals perished in volcanic catastrophes, and their corpses were brought down a large Pliocene river, so that before the bones were finally deposited and buried they must have been separated by the rotting of the flesh; and there are evidences of crocodiles having preyed upon the carcases.

The femur is so human-like that nearly all anatomists did not hesitate to declare it to be human; but up to the present no human remains had been found in the Lower Pleistocene, the oldest only reach down to about the middle of that period. Nobody had the slightest doubt that the bone must have belonged to a form with an erect posture. Only Virchow repeatedly maintained, even after seeing it, that it belonged to an ape, probably Hylobates, because it has, in his opinion, a straight, shaft such as never occurs in man; but the audience could easily see that the shaft of the fossil was by no means straight, and Dr. Dubois demonstrated some features which he had never seen in human femora, but which he believed to be simian characters.

For normal human proportions the capacity of the cranium was too small for the femur; but microcephalic skulls of the class which may be regarded as atavistic can be even relatively smaller, while the height of the body is more than that of Pithecanthropus, as computed from the length of the femur. Such was the case of the microcephalic idiot, Joe, described by Prof. Cunningham. The length of the Java cranium is 185 mm., its breadth 130 mm. The same dimensions in an average female chimpanzee's skull are 132 and 91, and those of a Hylobates 95 and 69. The internal capacity he estimated at 1000 cubic centimetres. The largest skulls of the anthropoid apes average about 500 c.c. Normal human skulls are known of an equal or even less size than the Java cranium; but these small skulls are always associated with a small body. The chances are enormously against this being the skull of an idiot, and no microcephalic skull shows such a flattening of the parietal region. The orbital part of the skull is quite different from that of man, but the inclination of the nuchal plane is far more human than simian. From the genus Hylobates he could only find a difference in size and in the downward slope of the occiput; the resemblance between the two was most striking if the former was enlarged two diameters.

A divergence of opinion also prevailed as to whether the teeth were human or simian; they were larger than human teeth, and the cusps showed a relative development which was characteristically simian.

From the whole geological and anatomical investigation it followed that in each of the four specimens they had evidence of a form intermediate and transitional between man and anthropoid apes. The problem was as to the exact position of this creature in the tree of genealogical descent.

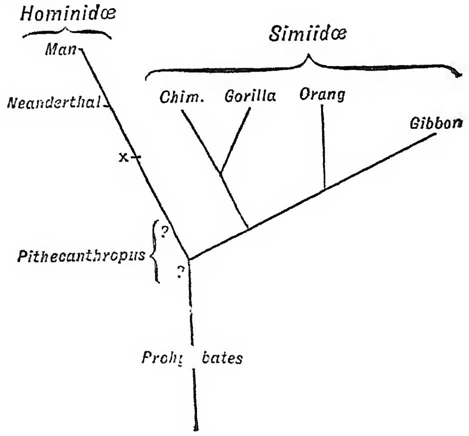
Dr. D. J. Cunningham, Hon. Secretary of the Society, believed the specimens to be of supreme importance. Discussing Dr. Dubois' memoir at a previous meeting of the Royal Dublin Society, he had expressed the view that the cranium was distinctly human, and he still held that an unbiassed study of the published description and figures could lead to no other conclusion. Now, however, when he was brought face to face with the actual specimen, he failed to see in it any decided and leading human feature, except its capacity of 1000 c.c. He agreed with Dr. Dubois in considering that it most resembled the cranium of Hylobates, although he was of opinion that Dr. Dubois slightly exaggerated the relative height and quality of the cranial arch in Hylobates. In this respect he considered that, if fairly tested, the fossil cranium would be found to be superior to any known ape. Certainly the cranial arch was vastly superior to that of a gorilla, chimpanzee, or orang, and he believed also that it was relatively fuller and loftier than the most highly-arched Hylobates cranium. Dr. Dubois placed some stress upon the inclination of the nuchal area of the occipital bone, and thought that in this there was a human characteristic; but he (Dr. Cunningham) thought that this region of the cranium was extremely ape-like, and, further, he did not altogether consider that the means which Dr. Dubois had taken to determine the degree of this inclination were calculated to yield absolutely trustworthy results.

With regard to the femur, he had nothing to add to what he had previously said on this subject. It was a human bone, and while he fully appreciated the distinctive points alluded to by Dr. Dubois, he thought that Dr. Dubois had not made sufficient allowance for the variation to which this bone was liable. It was, to say the least of it, strange that a thigh-bone of such undoubted antiquity should exhibit none of those characteristics which we were in the habit of associating with prehistoric femora, as well as with the femora of rude and savage races of the present day. It showed no signs which would indicate that the individual to whom it belonged was in the habit of assuming the squatting attitude.

In so far as the two molar teeth were concerned, he still held that the features which they exhibited were more human than simian, although it could not be denied that they also exhibited some very decided ape-like characters.

The question as to the place which should be assigned to the fossil form on the genealogical tree was a most interesting one. On this point he differed entirely from Dr. Dubois. Dr. Dubois placed Pithecanthropus below the point of devarication of the anthropoid apes from the human line. Dr. Cunningham, on the other hand, placed it on the human line, a short distance above the point at which the anthropoid branch is given off. In urging this view, he stated that he could not believe that an ape-form with a cranial capacity of 1000 could be the progenitor of the man-like apes, the largest of which had a capacity of only 500.

Such a supposition would necessarily involve the assumption that the anthropoid apes were a degenerated branch from the common stem. This view he explained by means of the accompanying diagram.



Prof. Haddon said: Ever since the evolution hypothesis had shed such an illumination upon nature, biologists had believed in the previous existence of forms intermediate between man and the lower animals; and it was with a fearful joy that they heard of Dr. Dubois' discovery, and then they subjected the remains to a searching criticism, with the result that all agreed that the individual to whom the cranium belonged was transitional in character between the apes and man—some thinking him more ape-like, and others more human; balancing the one set of opinions against the other, they could only come to the opinion that it was an intercalated type. Whilst agreeing with Dr. Dubois in all his statements of fact, he concurred with Prof. Cunningham in thinking that the size of the cranium was an insuperable difficulty in the way of placing the individual to which it belonged below the point in the genealogical tree where the anthropoids branched off. Palæontological evidence points to the fact that in the evolution of any series of mammals the brain tends to increase in size; at all events, there is no known case of a brain decreasing to less than half its original dimensions. Nor did it appear to him to meet the case to suppose that by doubling the body of a gibbon the brain would be equally doubled in size; there was no such proportion between body growth and brain growth.

Dr. Pearsall, a leading dental surgeon in Dublin, made some remarks about the teeth, and said that the human characters of the teeth were very striking.

Prof. Sollas agreed with the preceding speakers as to the invaluable evidence afforded by these fossil remains. They indicated an organism which was either a pithecoid man or a remarkably human ape; which of these alternatives might prove to be true was a matter of secondary importance, the fact remained that we had before us traces of the most simian ancestor of the human race yet known.

The materials for determining its geological age were abundant, but not yet fully worked out. Dr. Dubois, however, stated that the associated mammalian fauna stood in close relation to that of the Nerbada beds and the Upper Siwaliks of India; and so far as it might be possible to correlate the Javan deposits with those of Europe, they would appear to be older than our river-drifts, and possibly on the same horizon as the forest-bed of Norfolk. In this case the intervals in time, and the differences of structure which separate the Javan fossils from the race of Spy, and this from existing man would be, so to speak, proportional.

In the Miocene times we first meet with a few modern genera struggling to the front from a crowd of competitors; and in the Pliocene a few modern species emerge, and thus, in the case of the human race, we might expect to find the existing species *Homo sapiens* replaced by some earlier representative, say *Homo innocens* in the Pliocene, and the genus *Homo* by allied though different genera of the family *Hominidæ* in the Miocene. While, however, *Hominidæ* are not yet known from the Miocene, remains of anthropoid apes (*Dryopithecus*) are, and thus what palæontological evidence exists lends no favour to the view that the anthropoids are degenerate descendants from the human stem. Thus Prof. Sollas was less inclined to agree with Dr. Dubois than with Prof. Cunningham in estimating the human characters of the Javan fossils.

Dr. Dubois thanked the Society for the honour they had done him and for their kindness. He explained why he placed Pithecanthropus in a different position in the genealogical tree from that assigned to him by Prof. Cunningham. They knew very little about the laws of evolution, which in some cases proceeded slowly and in others quickly.

The proceedings then terminated.

SCIENCE IN THE MAGAZINES.

SEVERAL articles on more and less scientific topics appear in the *Contemporary*. Mr. Herbert Spencer contributes the seventh of his series of articles on the development of professional institutions, the subject this month being the teacher. It is shown that the primitive conception of the teacher is the conception of one who gives instruction in sacred matters, so that the priest and teacher were identical. The priesthood is, for a long time, the sole source of knowledge, but in the course of evolution the teaching functions of the priest are shared by a non-priestly class, and thus the secular educator comes into existence. Mr. Spencer quotes, in support of this theory of development, extracts from the records of peoples, past and present, in various parts of the world. The evidence adduced goes to show "how teaching was in the beginning exclusively concerned with religious doctrines and rites, and how there eventually began to rise a teaching which, in some measure detached from the religious institutions, at the same time entered upon other subjects than the religious." In some cases, the normal genesis of teachers from priests was interfered with, but that does not alter the general fact of such development. The differentiation of the teaching class from the priestly class is even now incomplete, for a large number of the private schools in our own kingdom are carried on by clergymen. Finally, as in other professions, segregation and consolidation into unions and associations have followed upon differentiation.

M. Berthelot, the renowned chemist, lately appointed French Minister for Foreign Affairs, was a close friend of Renan. A few incidents referring to that friendship, and what Renan might have thought of the appointment, are given in the *Contemporary* by Mr. Albert D. Vandam. The same review contains the first instalment of an article on "Physics and Sociology," by Mr. W. H. Mallock. The character of the article is sufficiently indicated by the following headings of the sections. (1) On the application to social phenomena of the methods and principles derived from physical science; (2) on the crucial difference between the subject-matter of physical science and that of social science, which render the method of study proper to the first inadequate when applied to the second; (3) on the deliberate rejection by contemporary sociologists of the methods by which, in social science, the methods of physical science must be supplemented; (4) on the nearness with which contemporary sociologists have approached the methods of study, which they have nevertheless missed or rejected. The *Contemporary* also contains articles on the Secondary Education Report, by Prof. J. Massie; Mr. Balfour's philosophic writings, by Mr. Norman Hapgood; and a reply, by Prof. A. A. Bevan, to an article in which Prof. Sayce dealt with Biblical criticism from an archæological point of view.

The first number of the English series of the *Popular Science Monthly* contains a large amount of readable matter on scientific topics. Accompanying a description, by Mr. H. P. Fitzgerald Marriott, of the Palæolithic skeletons discovered near Mentone in 1892 and 1894, are three good illustrations reproduced from photographs of the remains. Prof. Sully contributes an interesting paper entitled "Studies of Childhood," and there are also popular articles on consumption, the saltness of the sea, and other subjects. We notice a letter entitled "Are Animals Left-handed?" by Mr. D. S. Jordan. Several observers have stated that parrots grasp and hold food with the left claw, but Mr. Jordan concludes from his observations that "the appearance of left-footedness is due entirely to the fact that those who offer the finger or food to parrots do so as a rule with the right hand. Repetition of this process makes the parrot more or less left-footed in time."

Lieut. B. Baden Powell describes his "Air-Car, or Man-

lifting Kite" in the *National*, and expatiates upon its superiorities over the balloon. The machine consists of a varying number (usually four or five) of sails of a flattened hexagonal shape. These are connected, one behind the other, to the ground-line, from which latter is suspended a basket-car, which has a parachute spread out above it in case of accident. The number of kites required to lift the car depends upon the wind. Lieut. Powell has tried his kites on several occasions, once during the meeting of the British Association at Ipswich, and though the result has in a few cases been disappointing, yet on the whole they have been very successful. To sum up, he remarks: "We have here a machine capable of lifting a man safely to a height, which has many advantages over a balloon. It is infinitely more portable; it is infinitely less costly. It requires no reserve supplies, and is not precluded from ascending by too much wind. It is practically invulnerable, and it promises to be of use in many circumstances rendering a balloon impracticable." What Lieut. Baden Powell specially wants is that the War Department, or the Treasury, should thoroughly investigate his invention and completely put it to the test. Our present Army Balloon establishment costs £3000 a year, and Lieut. Powell thinks most of this would be saved if the air-car were used, and with no loss of efficiency.

In a long paper contributed to the same *Review*, Mr. Mortimer Granville gives to the world "A New Theory of Gout." It is for students of chemical physiology and pathology to estimate the value of the evidence brought forward; all we need do is to indicate the kind of conclusions arrived at, viz.: (1) That gout is not a malady having for its cause an over-production of uric acid. (2) Gout is a malady which has for its cause the presence in the organism of an undue proportion of leucocytes, not necessarily in the blood, but in the organs and tissues generally. (3) If this view of gout be the true one, the treatment of the malady must be the treatment of leuchæmia or anæmia. In other words, efforts should be made, by means of a meat diet, to multiply the red corpuscles in the blood, and so assist in bringing about a reduction of the white corpuscles—uric acid makers—within normal limits.

In *Scribner's Magazine*, under the title "Wild Beasts as they Live," Captain C. J. Melliss, a well-known authority on lion and tiger hunting, describes those animals from a sportsman's point of view, his article being illustrated by reproductions from a remarkable series of etchings of wild animals, by Evert van Muyden. Among the articles in *Knowledge*, we notice "The Filtration of Water," by Dr. S. Rideal; "Whip Scorpions and their Ways," by Mr. R. I. Pocock; and "New Stars," by Dr. A. Brester.

A passing reference must suffice for the remaining articles on scientific subjects in the magazines received by us. A paper on "The Limits of Natural Selection," contributed to the *Humanitarian* by Prof. C. Lloyd Morgan, is accompanied by a portrait of the author. A description of the arrangements made for the International Exhibition of 1900, with a plan showing where the exhibition will be placed, how the grounds will be divided, and what will be the names of the principal buildings, is given in the *Century*. Mrs. Lecky has in *Longman's* a very interesting account of the Institute of France, and the recent centenary celebrations. Among the subjects of popular articles in *Chambers's Journal*, we notice "The Metal Platinum," "Living Barometers," "Ivory," "Our Simian Cousins," "The Ancient Incas of Peru."

In addition to the magazines mentioned in the foregoing, we have received the *Fortnightly Review*, *Strand Magazine*, *Good Words*, and the *Sunday Magazine*, but no articles in them call for comment here.

SCIENTIFIC INVESTIGATIONS OF THE FISHERY BOARD FOR SCOTLAND.

THE part of the thirteenth annual report of the Fishery Board for Scotland, dealing with the principal scientific investigations carried on in 1894, in connection with the sea fisheries under the charge of the Board, has recently been issued. An idea of the scope and value of the work done may be obtained from the following summary:—

In the course of the year, the investigations, which were carried out under the supervision of Dr. T. Wemyss Fulton, were prosecuted on the same general lines as in previous years, and have resulted in further extensions of knowledge respecting the life-histories and habits of the fishes which form the basis of the fishing industry, and of the operation of certain methods of fishing in relation to the food supply. Besides such inquiries, which are necessary for the proper conservation and regulation of sea fisheries, the operations in the hatching and artificial propagation of some of the more important food fishes have been continued at Dunbar Marine Hatchery, which was completed last year, and which have resulted in the addition of over forty-five millions of the fry of plaice, turbot and cod to the fishing-grounds along the neighbouring coast. Similar establishments are now in operation in the United States, Canada, Newfoundland and Norway, and others are in process of being formed in France and in Lancashire.

As in previous years a large part of the scientific inquiries, both biological and physical, have been carried on or rendered possible by means of the *Garland*, the small steamer obtained by the Board for this work; but, as has been mentioned in previous reports, her small size has curtailed the extent and usefulness of the investigations.

Part of the scientific work was also carried on at the marine laboratories at St. Andrews and Dunbar.

THE HATCHING AND REARING OF FOOD FISHES.

In last year's report the reasons which induced the Board to establish a hatchery for sea-fishes at Dunbar were given, together with a detailed description and plans of the building, and an account of the work during the first season it was in operation. The present report contains an account by Mr. Harald Dannevig, who is in charge of the hatching work, of what has been accomplished during the current season, and of the work now in progress. It is satisfactory to be able to note that the various pumping and incubating apparatus have continued to work well and without any hitch, and that the number of fry of the food fishes which have been successfully dealt with this season considerably exceeds the number turned out last year.

The great majority of the young food fishes which have been propagated have consisted of plaice, of which 44,085,000 eggs were obtained from the spawning pond, yielding 38,615,000 fry. The number of cod hatched numbered 2,760,000, and the number of turbot 3,800,000. This seems to be the first time that the eggs of the turbot have been hatched at any hatchery, and the success in this respect has enabled the development of this important fish to be studied and described by Prof. M'Intosh.

In regard to the practical results of marine pisciculture in adding to the fish supply, it may be stated that in the United States, Newfoundland and Norway—where cod alone has been propagated on a large scale—according to the official reports published in these countries the abundance of young cod has been materially increased. In the neighbourhood of the hatchery on Dildo Island, Newfoundland, the shoals of this fish were so numerous during the past season that they were described as a "solid thick mass covering the bottom for long distances on both sides of the island," and it is stated that fishermen from other parts, on hearing of the abundance of cod, came to Dildo to fish. Sufficient time has not, of course, elapsed since active operations were begun at Dunbar to afford any indication as to the influence of the work in increasing the fish supply, but there are some points of importance that may be considered in connection with the subject. There can be no doubt that the great majority of the fry distributed on the fishing grounds are destroyed from natural causes; but if only a fraction of one per cent. survive, the resulting benefit would far exceed the expenditure upon the work. If one in a hundred of the fry distributed from the hatchery survived, and if the price of the marketable fish be placed at sixpence, the resulting value to the fisheries would be about £18,000. It would require the survival of only one in a thousand, and the marketable fish to be sold at only one penny each, to cover the expenses of the work.

THE INFLUENCE OF MARINE CURRENTS IN TRANSPORTING FLOATING EGGS AND LARVÆ FROM OFFSHORE SPAWNING AREAS.

Previous investigations have shown that the inshore waters are destitute of spawning grounds for the great majority of the food fishes, and that they receive their supplies from the spawning areas situated at some distance from shore. In the present report a preliminary account is given, by Dr. T. Wemyss Fulton, of experiments which have been made to determine the influence of marine currents in transporting the floating eggs and young fishes to various parts of the coast. It is shown that they may be carried in the course of their development long distances in a

definite direction, to other parts of the coast, and that the fish supply of a given area of the territorial waters on the east coast may be derived, not from the spawning areas *ex adverso*, but from those situated further north.

THE LIFE-HISTORIES AND DEVELOPMENT OF THE FOOD FISHES.

The report contains an important paper by Prof. M'Intosh, giving the results of his continued investigations on the eggs, young, and development of several of the food fishes, the work having been carried on, as in previous years, at St. Andrews Marine Laboratory. The principal investigation relates to the development of the turbot, which has now for the first time been elucidated, fertilised eggs having been procured from the hatchery. The ripe egg of the turbot has an average diameter of 1·0287 mm., and is perfectly buoyant, floating at the surface of still water or suspended midway, and it possesses a prominent oil-globule. The embryonic fish, which is of a reddish colour, emerges from the egg about the sixth or seventh day, so that the period is short before hatching occurs. The larvæ in a few days become active and dart rapidly through the water, and they are hardy; the yolk-sac becomes absorbed about the seventh day, and thereafter they feed for themselves, being extremely quick in noticing the movements of the minute crustaceous and other forms in the water around them. Prof. M'Intosh states that no form hitherto observed at St. Andrews appeared to be more hardy, or to undergo the vicissitudes of temperature and manipulation with greater impunity than the young turbot; there are grounds, therefore, for expressing the hope that they may yet be reared in great numbers from the post-larval to the adolescent and adult condition in suitable enclosures. The various stages in the development of this valuable form are described and figured. Another species whose development is described is the long rough dab, the pelagic eggs of which are found in considerable abundance in March and April.

Mr. H. Charles Williamson contributes an elaborate paper on the reproduction of the common eel, which has been, and still is, in many respects, involved in considerable obscurity. He gives a very full account of the reproductive organs, both as described by other naturalists, and as observed by himself in a number of specimens examined at St. Andrews; and the paper includes a description of the migrations of the eel, and all that has been ascertained about its spawning. It is a remarkable fact that the ripe egg of the eel has never yet been discovered.

Mr. Williamson also gives a detailed account of the distribution of the pelagic eggs and larvæ of various species of food fishes, obtained in tow-nets, including those of the plaice, haddock, cod, whiting, saithe, sprat, dab, turbot, gurnard, long rough dab, flounder, &c. In another paper he describes the variation in the size of the eggs of a number of the food fishes. Dr. Fullarton has also furnished an elaborate description of the larval and post-larval development of the brain in the lesser sand-eel (*Ammodytes tobianus*), accompanied by illustrations. The important subject of the rate of growth of fishes is at present receiving considerable attention in connection with fishing questions. In the present report Mr. Arthur T. Masterman gives the result of his researches on the subject at St. Andrews, dealing especially with the rate of growth of the plaice.

Mr. Harald Dannevig also furnishes an account of the experiments he has made in regard to the influence of variations of temperature in accelerating or retarding the development of the eggs of fishes. The species dealt with were the plaice, cod, haddock, whiting and flounder.

Finally, the report contains a paper, by Mr. Thomas Scott, on the fauna of the Firth of Forth area and of inland waters; Mr. A. J. Herbertson contributes an elaborate paper, accompanied by numerous tables, dealing with the physical observations on the temperature and density of the sea; and Dr. Wemyss Fulton gives an account of the scientific fishery work and the condition and regulation of the sea fisheries in other countries possessing them, and of the principal methods employed to protect and develop them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. A. R. Forsyth, F.R.S., Sadlerian Professor of Pure Mathematics, has been appointed by the Council of the Senate a member of the Governing Body of Eton College, in the room of Dr. Ferrers, F.R.S., resigned.

An Isaac Newton Studentship in Astronomy and Physical Optics will be vacant in the ensuing Lent term. The studentship is of £200 per annum for three years. Candidates must be at least B.A.s of the University, and under the age of twenty-five on January 1, 1896. Their names should be sent to the Vice-Chancellor between January 14 and 24 next, together with statements as to course of study or research proposed in each case.

The Observatory Syndicate report that they have abandoned the expectation of receiving public subscriptions for the proposed photographic telescope. They now contemplate the erection of a triple apochromatic telescope, the objective of which is to be furnished by Messrs. Cooke, of York, at a cost of £550. The tube of the instrument will be hinged, the larger part of the tube with the eye-piece lying in the polar axis. The rays from the objective at the end of the short movable part of the tube will fall on a flat mirror at the hinge, and be thence reflected to the eye-piece. The flat mirror will be furnished as a gift by Dr. Common, and Sir Howard Grubb is to be entrusted with the construction of the tube at a cost of £1100. The necessary moneys it is proposed to draw from the Sheepshanks Funds, and the Syndicate ask the Senate to sanction this appropriation.

Prof. Ewing, F.R.S., has been appointed Chairman of Examiners for the Mechanical Sciences Tripos, 1896. Among the annual appointments of members of the various Boards and Syndicates are the following:—Mr. Glazebrook, F.R.S., General Board of Studies; Mr. W. Gardiner, F.R.S., and Mr. W. Bateson, F.R.S., Botanic Garden Syndicate; Mr. Love, F.R.S., Library Syndicate and Observatory Syndicate; Mr. Heycock, F.R.S., Museums Syndicate; Dr. Hobson, F.R.S., Proctorial Syndicate, and Mathematical Board; Mr. Capstick, Highest Grade Schools; Prof. Bradbury and Dr. Shore, State Medicine; Dr. D. Hill, Agricultural Science; Mr. Shaw, F.R.S., Fire Prevention, and Board for Physics and Chemistry; Dr. A. MacAlister, Special Board for Medicine; Dr. Gaskell, F.R.S., Board for Biology and Geology.

It is proposed to invite representatives of the chief educational authorities and institutions to meet in Cambridge during the ensuing Long Vacation, in order to confer on questions arising out of the Report of the Royal Commission on Secondary Education. The Vice-Chancellor, on behalf of the University, will convene the conference.

THE Calendar of the University College, Nottingham, for the fifteenth session, 1895-96, has been issued.

THE following are among recent appointments:—Dr. J. Munk to succeed Dr. Gad at the Berlin Physiological Institute; Dr. Paul Kempf and Dr. Wilsing, of the Potsdam Astrophysical Observatory, to be Professors; Prof. Theel, of Stockholm, to be Director of the Natural History Museum there; Dr. Strahl, of Marburg, has been appointed to the chair of Anatomy in Giessen University.

THE *London Technical Education Gazette*—the official organ of the Technical Education Board of the London County Council—contains the following satisfactory announcement:—"It has been part of the policy of the Technical Education Board in connection with higher education, and will be, if possible, through the proposed Teaching University of London, when that University is established, to secure for students who can devote their evenings only to study, a course of instruction of the highest type in all branches for which provision is now made for day students in the universities and university colleges, and to provide that the teachers of these classes shall be the same professors as take the day classes, or others of equal standing. As a step in this direction the Board has arranged with the authorities of University College for the conduct of four courses of lectures and practical work in the departments of Mechanical Engineering, Electrical Engineering, Chemistry, and Applied Mathematics."

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, November 7.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—On flame temperatures and the acetylene theory of luminosity, by A. Smithells. The author criticises adversely Lewes's theory of the luminosity of hydrocarbon flames on the ground of ex-

perimental evidence.—A new series of hydrazines, by F. D. Chattaway and H. Ingle. The quaternary hydrazines of the general formula $R_2N.NR_2$ may be prepared from secondary amines by acting on the sodio-derivatives of the latter with iodine.—The action of certain acidic oxides on salts of hydroxy-acids (part ii.), by G. C. Henderson and D. Prentice. A number of crystalline compounds of antimonious and arsenious oxides with salts of citric, malic and mucic acids have been prepared.—Sodium nitrososulphate, by E. Divers and T. Haga.—The constitution of nitrososulphates, by E. Divers and T. Haga. In these two papers the authors detail evidence showing that the nitrososulphates are true sulphates of the constitution $RON_2.O.SO_3K$.—Normal hexane from light petroleum (petroleum ether), by G. L. Thomas and S. Young. Employing their recently described form of dephlegmator, and treating the fractions with mixed nitric and sulphuric acids, the authors have been able to separate an almost pure sample of normal hexane from light petroleum.—The vapour pressures, specific volumes and critical constants of normal hexane, by G. L. Thomas and S. Young. The critical temperature, pressure and volume of a gram of synthetic normal hexane are 234°.8, 22510 mm. and 4·268 c.c. respectively: the oil boils at 69°·0 under 760 mm., and has the specific gravity 0·67696 at 0°.—Acidylthiocarbimides, by A. E. Dixon.—Some constituents of the root of *Polygonum cuspidatum*, by A. G. Perkin. From the roots of this plant, which is a native of China and Japan, the author has separated a new glucoside, cuspidatin, $C_{21}H_{20}O_{10}$, which yields emodin on hydrolysis; a second glucoside, emodin, and a wax were also isolated.—Note on the action of hydrofluoric acid upon crystallised silicon, by G. S. Newth. Gaseous hydrogen fluoride causes the ignition of warm crystallised silicon.—Note on the periodides of theobromine, by G. E. Shaw. The author has prepared four new periodides of theobromine and its hydrochloride.—A synthesis of diphenyloxytriazoline, by G. Young.—Note on piperovatine, by W. R. Dunstan and F. H. Carr. Piperovatine may be rapidly extracted from *Piper ovatum* by percolating the material with ether.—Dibenzaconine and tetracetylaconine, by W. R. Dunstan and F. H Carr.—Molecular volume change during the formation of dilute solutions in organic liquids, by A. W. Jones. A series of determinations of the volume changes occurring when a number of liquids are dissolved in benzene and carbon disulphide have been made.

Royal Meteorological Society, November 20.—Mr. R. Inwards, President, in the chair.—A paper by Mr. J. Eliot, F.R.S., was read, on the origin of the cold weather storms of the year 1893 in India, and the character of the air movement on the Indian seas and the equatorial belt, more especially during the south-west monsoon period. This was really a discussion of the data contained in the *Indian Monsoon Area Charts*, the publication of which was sanctioned by the Indian Government for the two years 1893-4. Cyclonic storms are of frequent occurrence during both the north-east and the south-west monsoons, but they differ in many important respects. The storms of the south-west monsoon originate almost invariably over a sea surface, and travel in very variable directions, and occasionally develop into intense and furious hurricanes. The cyclonic storms of the north-east monsoon almost invariably originate over the plateau of Persia or Baluchistan, or in North-Western India, and travel in an easterly direction at a velocity ranging between fifteen and twenty miles per hour. These plateau-formed storms of the cold weather are the chief instruments of the distribution of the moderate rainfall essential for the great cold weather wheat and other crops of Northern India, and are the chief sources of the snowfall of the Western Himalayas. After giving an account of the more important cold weather storms in January and February 1893, and the results of the tabulation of the wind observations for the equatorial belt, the author describes the "burst of the monsoon." Mr. Eliot says that the evidence of the year 1893 is strongly in favour of the supposition that the south-west monsoon currents in the Indian seas are the direct continuation north of the equator of the horizontal movement of the south-east trade winds; and that the larger variations in the strength of the south-east trades near the equator during the monsoon period are reproduced in the monsoon currents in the Indian seas from June to September.—Mr. W. H. Dines showed an interesting experiment to illustrate the formation of the tornado cloud. The characteristic funnel cloud was readily seen extending from the tray of hot water to the mouth of the pipe at the top of the box, and when the draught was strong and the conditions favourable, a decided protuberance was observed on the surface of the water just under the end of the cloud. Mr. Dines is of opinion that the cloud is formed by true dynamic cooling as the air, saturated by the vapour from the hot water, comes under the influence of the decreased pressure at the centre.—A paper by Mr. C. Davison was also read, on the diurnal variation of wind velocity at Tokio, Japan.

Malacological Society, November 8.—Prof. G. B. Howes, President, in the chair.—The following communications were read:—Descriptions of new species of terrestrial and fluviatile mollusca from the Hadramaut, South Arabia, by J. C. Melvill and J. H. Ponsonby.—Notes on the anatomy of *Hanleya abyssorum*, M. Sars: (*a*) on the presence and position of an osphradium; (*b*) general notes, by R. H. Burne.—Description of a new species of the genus *Cassis*, by G. B. Sowerby.—Description of a new species of *Vitrina* and new forms of *Helicidæ* together with a list of the Helicoid land-shells hitherto found in the Canary Islands, by G. K. Gude.—Description of a new species of *Streptaxis*, by G. K. Gude. Specimens in illustration of their respective papers were exhibited by the authors.—Mr. Da Costa exhibited a series of land-shells from the Galapagos Islands. Mr. Moss exhibited a white *Helix perplexa*, Fér., from Grenada.—Mr. Sykes exhibited land-shells from a deposit at Blashenwell, Dorset.

PARIS.

Academy of Sciences, November 25.—M. Marey in the chair.—On para-ethoxyquinoline, by M. C Grimaux. The production and properties of para-ethoxyquinoline and some of its derivatives are described Conforming to Skraup's nomenclature, the name quinethol is given to this substance and its derivatives are termed nitroquinethol and amidoquinethol.—Observations of small planets, made with the great equatorial of Bordeaux Observatory, by MM. G. Rayet, L. Picart, and Féraud.—M. Lannelongue has been nominated by vote as member of the Medicine and Surgery Section of the Academy.—The rapid estimation of nitric nitrogen in vegetable products, by M. P. Pichard. The method is a colorimetric process based on the colouration produced when nitric acid acts on brucine.—Observation of the new comet Perrine (November 16, 1895), made at Marseilles Observatory, by M. Esmiol.—The polar snows of Mars, by M. Camille Flammarion. A comparison of some observations by the author with observations recorded at Lick Observatory.—On the displacement of a trihedral trirectangle around its summit, the position of this trihedral figure depending on two parameters, by M. Maurice Fouché.—On the electro-capillary properties of dilute sulphuric acid, by M. Gouy.—Action of phenol on mercurous iodide, by M. Maurice François. It is shown that phenol has a similar action on mercurous iodide to that of aniline. A certain proportion of the salt is decomposed to mercuric iodide and mercury until a state of equilibrium is set up between this action and the reverse action. Equilibrium obtains when 100 grams of solution contain 2·75 grams of mercuric iodide.—On manganese silicide, by M. Vigouroux. The compound $SiMn_2$ has been produced (1) by the direct action of silicon on the metal, (2) by the action of silicon on the oxide, (3) by the action of carbon on a mixture of silica and oxide. It is a very hard and sonorous substance of metallic lustre, and perfectly crystallised. Its aspect is steel-grey, density at 15° = 6·6, and it is unalterable in the air and fusible at the temperature of the reverberatory furnace. The chemical properties are given in detail in the paper.—On the toxicity of acetylene, by M. L. Brociner. A note calling attention to some of the author's work published in 1887, and prior to the recent publication on this subject of M. Gréhant.—On some reactions of tartaric acid and alkaline tartrates, by M. L. Magnier de la Source.—On the morphological interpretation of double larvæ in composite Ascidians of the genus *Diplosoma*, by M. Maurice Caullery.—On the effects produced on the rabbit and pigeon by the extraction of the stapes or of the columella and the experimental lesion of the membranous vestibule, by M. Garnault.—Laccase in fungi, by MM. Em. Bourquelot and G. Bertrand.—On the distribution of nitrogenous and mineral matters in bread, by M. Balland.

BERLIN.

Physiological Society, October 25.—Prof. du Bois Reymond, President, in the chair.—Dr. René du Bois Reymond gave an account of experiments made in repetition of Martin's, on the action of the internal intercostal muscles. He confirmed the

conclusions arrived at by this investigator, but he more particularly limited his experiments to an examination of the internal intercartilaginous intercostals. It appeared that the latter, in opposition to the expiratory action of those between the ribs, have an inspiratory function, and contract synchronously with the diaphragm. After an artificial apnœa they enter again into activity at a slightly later period than does the diaphragm, resembling in this the inspiratory external intercostals. Dr. Rawitz recommended the employment of a very dilute solution (three to five drops of the concentrated ammoniacal solution in 30 to 50 c.c. of distilled water) of either hæmatoxylin or hæmatein, when these are used for staining, either alone or as subsequent to the use of eosin. The sections should lie in this solution for twenty-four to forty-eight hours. He then spoke on the use of alizarin and alizaro-cyanin for histological purposes. These substances can only be used with a mordant, of which a chromium salt was found to be most efficient with the former stain, and a salt of iron with the latter. In this way very brilliant permanent stainings may be obtained, which are particularly suited for the investigation of nuclear division.—Dr. Benda exhibited some striking preparations of neuroglia, obtained by a method to be described later on.

Physical Society, November 1.—Prof. du Bois Reymond, President, in the chair.—Dr. Claude du Bois Reymond exhibited specimens of colour-photographs, made by Dr. Joly, of Dublin, and described how they had been obtained. Dr. Rubens gave an account of experiments made by D. C. Cole on the refractive index of water and alcohol for electrical rays of short wave-length. Having failed to obtain any results with a prism for rays of 5 cm. wave-length, he used Fresnel's formula and the reflexive powers of these fluids for vertical and parallel polarised rays. In this way he found that for water the coefficient for rays of the above wave-length is the same as for rays, as previously investigated, of 10 cm. and of 60 cm. In the case of alcohol it was markedly less for rays of shorter than for those of greater wave-length. The method was also applied to petroleum, and gave results similar to those previously obtained for this liquid by other methods.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 4.30.—Studies in the Morphology of Spore-producing Members. Part II. Ophioglossaceæ: Prof. F. O. Bower, F.R.S.—On the Weight of a Cubic Decimetre of Water at its Maximum Density: Prof. Mendeleeff, For. Mem. R.S.—The Measurement of High Potential Difference: H. C. Leake, R. Leventhorpe, and C. S. Whitehead.—Variations in the Electromotive Force of Clark Cells with Temperature: Prof. Ayrton, F.R.S., and W. R. Cooper.

LINNEAN SOCIETY, at 8.—On a New Species of Bromus in Britain: G. C. Druce.—Notes on New or Rare Phasmidæ in the Collection of the British Museum: W. F. Kirby.

LONDON INSTITUTION, at 5.—Old Musical Instruments: A. Dolmetsch.

CHEMICAL SOCIETY, at 5.—The Constitution of Terpenes: Prof. Armstrong, F.R.S.—New Derivatives from α-dibromo Camphor: Dr. M. O. Forster. The Chemistry of Dibromopropyl Thiocarbimide, and the Action of Bromine and Iodine on Allyl Thiourea: Prof. A. E. Dixon.—Ballot for the Election of Fellows.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, DECEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on Indian Geology, including a Visit to Kashmir: W. H. Hudleston, F.R.S.

QUEKETT MICROSCOPICAL CLUB, at 8.

SUNDAY, DECEMBER 8.

SUNDAY LECTURE SOCIETY, at 4.30.—Lecture by Sir B. J. Richardson, F.R.S.

MONDAY, DECEMBER 9.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in the Central Alps of Japan: Rev. Walter Weston.

SOCIETY OF ARTS, at 8.—Mechanical Road Carriages: W. Worby Beaumont.

TUESDAY, DECEMBER 10.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—The Recording of High Temperatures by Photographic Means: Prof. W. C. Roberts-Austen, C.B., F.R.S.—A New Form of Apparatus for Measuring the Densities of Photographic Plates: Chapman Jones.

ROYAL VICTORIA HALL, at 8.30.—The Rhine: Prof. H. G. Seeley, F.R.S

ROYAL ASIATIC SOCIETY, at 3.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Discussion upon the Papers by Messrs. Arnold and Wrightson, on the Physical Properties of Iron and Steel.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Game of Teetotum, Queensland: R. Etheridge.—Notes on Australian Shields, more particularly the Drunmung: R. Etheridge.—Stone Cooking-Holes and Grooves for Stone-Grinding, used by the Australian Aborigines: R. H. Mathews.—The Burbung of the Wiradjuri Tribes: R. H. Mathews.—The Bora, or Initiation Ceremonies of the Kamilaroi, Part II.: R. H. Mathews.

WEDNESDAY, DECEMBER 11.

SOCIETY OF ARTS, at 8.—Adjourned Discussion on Mr. Cunynghame's Paper on Locomotive Carriages for Common Roads.

PHARMACEUTICAL SOCIETY, at 8.30.

THURSDAY, DECEMBER 12.

ROYAL SOCIETY, at 4.30.

LONDON INSTITUTION, at 6.—The New Far East: Arthur Diósy.

SOCIETY OF ANTIQUARIES, at 8.30.

MATHEMATICAL SOCIETY, at 8.—Note on the Convergency of Series: Dr. R. Bryant.—Sexdecimic Residuality of 2: Lieut.-Colonel Allan Cunningham, R.E.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, DECEMBER 13.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.—The Culture of the Edible Oyster: Prof. Herdman, F.R.S.

CLINICAL SOCIETY, at 8.30.

PHYSICAL SOCIETY, at 5.—A Mechanical Device for performing the Temperature Corrections of Barometers: Dr. John Shield.—On the Existence of Earth-Air Electrical Currents: Prof. A. W. Rücker, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.

SATURDAY, DECEMBER 14.

ROYAL BOTANIC SOCIETY, at 3.45.

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THURSDAY DECEMBER 12, 1895.

THE HISTORY OF MATHEMATICS.

Geschichte der Mathematik im Alterthum und Mittelalter. Vorlesungen von H. G. Zeuthen. Pp. viii. + 344. (Kopenhagen: Höst, 1896.)

A Primer of the History of Mathematics. By W. W. Rouse Ball. Pp. iv. + 146. (London: Macmillan and Co., 1895.)

THE first of these books is a translation, with some alterations and additions by the author, of a work originally published in Danish in 1893. Its aim is to supply students and teachers of mathematics with trustworthy information about such parts of the history of the subject as are really important for them to know; and, in particular, account has been taken of the fact that candidates for the Danish teachers' certificate are expected to show an acquaintance with the text of Euclid's Elements, as well as a general knowledge of the history of mathematical science. This plan has been effectively and judiciously carried out, and the result is a work of permanent value and interest, admirably suited for the class of readers for whom it is designed.

Dr. Zeuthen has very wisely adopted the course of tracing the lines of formal development along which the science of mathematics has progressed. This does not exclude the special consideration of the works of mathematicians of first-rate importance, while at the same time it brings clearly before us the different springs and rivulets, so to speak, which have converged into the broad and deep streams of modern geometry and analysis. Thus we are shown how the speculative and logical intellect of the Greeks built up a system, mainly geometrical, which at last seemed to become inert from the very perfection of form which it had attained; how the decimal notation of arithmetic and the elements of algebra, slowly evolved by the Indians, eventually made their way into Europe; and, finally, how mathematical science, preserved from extinction by the Arabs amid the ignorance and bigotry of the dark ages, woke up to new life in the thirteenth century, and grew slowly but steadily thenceforth, until the analytical method of Descartes and the invention of the infinitesimal calculus marked the beginning of a new era, the splendour of which has perhaps unduly obscured the achievements of all the ages which went before. We are all too apt to forget what we owe to our forgotten, unhonoured ancestors; and it is well that we should be now and then reminded that the exact science to which we are indebted for mos our "triumphs of civilisation," and which is ruly the finest product of the human mind, may be traced back to the dawn of history and the rude efforts of primitive man in the arts of counting and measuring.

But to return to Dr. Zeuthen's book. After a few introductory pages, devoted to *Vorgeschichte* and the Egyptians and Babylonians, we reach the longest and most interesting section of the work—that which treats of Greek mathematics. Here we have a clear, well-proportioned outline of the progress made from Thales to Diophantus, and of the scope and methods of Greek geometry and arithmetic, together with a sufficient analysis of the works of Archimedes, Apollonius, Diophantus, and more particularly Euclid. An interesting account is also given of the researches connected with the three famous problems of antiquity—namely, the trisection of an angle, the duplication of a cube, and the quadrature of a circle. (Archytas's construction for the second of these problems (pp. 84–5) is not very easy to follow: it would be an improvement to give a figure showing the circle traced out by the point Y.)

The amount of space given to the discussion of Euclid's Elements is justified by the importance of the subject. Dr. Zeuthen's criticisms of the definitions and postulates, and of Euclid's geometrical presuppositions, are very instructive; and his analysis of the contents of books v., vii.–xiii., ought to be of great service to students of the original text. There is only one point about which we would venture, with all respect, to differ from the author's conclusions. Dr. Zeuthen appears to regard the arithmetical books, and in particular book vii., as containing a theory of commensurable quantities; so that, for instance, the theory of proportion in book vii. is merely the substance of book v. adapted to commensurable ratios, and was composed because the general theory of proportion was still unfamiliar. This is not very plausible, *prima facie;* and it is, we think, disproved by the facts of the case.

The second definition of book vii. undoubtedly means "A number is an assemblage (πλῆθος, not μέγεθος) composed of units"; and if the word μονάς has the same meaning in the first definition that it has in the second (and this is almost necessarily the case), the true sense of the first definition will be "Any object whatever is a unit [or is regarded as a unit] when it is spoken of as *one*." If this be so, it is quite clear that we have to deal with a purely arithmetical theory; and there is nothing whatever in the form or matter of the seventh book inconsistent with this conclusion. It may be added that the definition of proportion in the seventh book is essentially distinct from that in the fifth; and that in some MSS., at any rate (*cf.* Gow's "History of Greek Mathematics," p. 74, note 3), numbers are represented by dots, and not by lines.

On the other hand, the tenth book does deal with quantities, and begins with a definition of commensurable quantities; a definition which, according to Dr. Zeuthen's theory, ought to have been given long before. It is quite possible that Euclid perceived the analogy between commensurable numbers and commensurable magnitudes; whether he realised the ratio of two commensurable quantities as a fraction in precisely the same wa as we ao s doubtful: it is almos certain that he ha no conception of surds as *numerical* quantities.

The Indians did not scruple to introduce irrational as well as negative numbers; by so doing, and by their invention of the decimal system of notation, they immensely extended the range of analysis, probably without knowing what they did. Except in the region of diophantine analysis, their particular discoveries are comparatively unimportant. However, Dr. Zeuthen does them full justice for all their researches; and we are glad, also, to see that he has a kindly word for the Arabs, who not only guarded the treasures of learning, but added something of their own to the store. Thus

we learn that Alkhojandi, about 1000 A.D., discovered that the equation $x^3 + y^3 = z^3$ does not admit of rational solutions.

A brief outline of the period 1200–1500 brings this excellent book to its conclusion. That it is the outcome of independent and careful research is evident; and the reader's appreciation of this fact is rather enhanced than otherwise by Dr. Zeuthen's graceful acknowledgment of his obligations to his predecessors in the same field, more particularly to Cantor and Tannery.

Mr. Ball's "Primer" is a work of a very different scope. Its object is "to give a popular account of the history of mathematics, including therein some notice of the lives and surroundings of those to whom its development is mainly due, as well as of their discoveries." It is expressly said that it is not intended for those to whom the subject is familiar. The plan adopted is to give a series of brief biographies in chronological order, interspersed with occasional paragraphs on particular periods. The necessary element of "human interest" is supplied by a number of anecdotes. Many of these are pertinent enough; others are certainly superfluous. Why should half a page be devoted to the unhappy matrimonial experiences of Kepler? or, again, what is the value of the information that Descartes in Paris was "modestly clad in green taffety?"

Still, the book is entertaining, and, although very sketchy, fulfils its purpose well enough until we come to the last section, which treats of recent mathematics. Here the difficulties of the subject, and the narrow limits of his plan, have been too much for the author. That this should be the case is not altogether surprising; but some of the faults of omission and commission are too serious to be passed over.

Thus in the paragraph on Cauchy, no mention is made of his work on the theory of numbers, or of his great memoir on waves. The statement that "the rule for finding the principal values of integrals was enunciated by him, and the calculus of residues was his invention," is much as if one should say "Newton discovered the binomial theorem and wrote the 'Principia.'" Worst of all, the account concludes with the remark: "In many of his memoirs the feverish haste with which they were thrown off is too visible, and several are marred by obscurity, repetition of old results, and blunders." Such criticism of a great genius is in questionable taste, and is apt to recoil on the person who makes it. It seems to us rather obscure to say (p. 132) that "in this theory the theta-functions are independent of the form of their space-boundaries"; and that Eisenstein "considered the theorems relating to the possibility of representing a number as a sum of squares, and showed that the general theorem was limited to eight squares." Will not the general reader infer from this that no number is the sum of more than eight squares?

Then as to inadvertent errors (it would be unkind to call them blunders): (1) it is not true that "the only regular polygons which can be constructed by elementary geometry are those of which the number of sides is $2^m(2^n + 1)$, where m and n are integers and $2^n + 1$ is a prime"; even Euclid could construct a regular quindecagon; (2) the theory of ternary quadratic forms is not due to Eisenstein; (3) Eisenstein did not give a rule for distinguishing whether a given series represents an algebraical or a transcendental function (see Heine's "Kugelfunctionen," 2nd edition, i. p. 50); (4) Abel did not prove that it is impossible to solve a quintic equation by means of radicals, but the quite different proposition that a root of the *general* quintic cannot be expressed in terms of its coefficients by means of radicals.

Finally, the omission of all notice of Galois is entirely inexplicable. The pathetic story of his death appeals to universal sympathy, and might even draw a tear from the hardened general reader; while the influence of his work upon recent analysis is, perhaps, second only to that of Riemann.

Fault-finding is not pleasant, and is apt to bulk too largely in a review. Mr. Ball's readers may not be impressed by the fact that Cayley "introduced the so-called 'absolute,'" and they may be inclined to think that "homaloidal hyper-space" is a somewhat technical expression; but they will find plenty of amusement in the "Primer," and a good deal of instructive reading; while, for reasons which are different, but each sufficient, the occasional *lapsus calami* will do neither the instructed nor the uninstructed reader any harm. G. B. M.

THE SPIDERS OF BURMA.

Descriptive Catalogue of the Spiders of Burma, based upon the Collection made by Eugene W. Oates, and preserved in the British Museum. By Dr. T. Thorell (London: printed by order of the Trustees, 1895.)

DURING his residence in British Burma, in the capacity of civil engineer, Mr. E. W. Oates availed himself of the rare opportunities of travelling, afforded by his official duties, to investigate certain portions of the fauna of the country, choosing as objects of special study such diverse groups as Scorpions, Whip-Scorpions, and Spiders; Centipedes and Millipedes; and Birds. It was, we believe, primarily his intention to work out all his collections himself upon his return to England on furlough. In fact, while still in the East he published, in the *Journal of the Asiatic Society of Bengal*, descriptions of his new species of Whip-Scorpions (*Thelyphonus*), and shortly after his arrival, his paper upon the Indian and Burmese species of Scorpions of the genus *Isometrus* appeared in the *Journal of the Bombay Natural History Society*. But further than this, his studies in the invertebrate portion of his material did not go; and realising the impossibility of grappling in the space of time at his disposal with the vast number of species of spiders and myriapods that he had procured, he generously presented these in their entirety to the Trustees of the British Museum, and devoted his energies to the study of the Birds of British India and Burma, of which he had already acquired considerable knowledge. In the course of the next few years, the Centipedes and Millipedes were determined and reported upon in a series of memoirs that appeared in the *Annali del Museo Civico di Genova*. The spiders, however, were, at Mr. Oates's request, submitted for examination to Dr. T. Thorell, who had already made himself an authority upon Burmese Arachnida, in connection with the study of the material of this group amassed under the auspices of the Marchese G. Doria by that practised

collector, Sig. L. Fea. But although the Italians, n the persons of Sigg. Fea and Comotto, had had the first bite at the Burmese Arachnid fauna, the careful sorting and examination of Mr. Oates's collection soon showed that this gentleman had more than doubled the number of known Burmese spiders. For whereas only 175 species had been previously recorded, the total number now amounts to no less than 381. Mr. Oates's collection thus contains 206 species that are new to Burma, and of these 153 appear to be new also to science. It comprises, moreover, either the males or females of many species of which only one sex had been hitherto described.

The secret of Mr. Oates's success as a collector of spiders is to be attributed partly, of course, to his paying special attention to them, but largely to his ingenious mode of attracting them. He tells us that—

"The greater part of the collection was made at Tharrawaddy [a station about seventy miles north of Rangoon], where I had a large garden, and a portion of it was specially prepared for the attraction of spiders, which came to it in large numbers. I put in plants of those species which my experience told me were specially affected by spiders, and by this means I was able to observe very many species in a small compass. By carefully watching the females for some weeks, I generally contrived to secure the males in such a manner as to render their identification with their respective females certain. In addition to the garden, there were large forests not far from my house. I collected at all seasons of the year, but I found the rains, from May to October, most productive. I was greatly assisted by my wife, who soon overcame her natural repugnance to spiders, and handled them freely."

With such exceptional opportunities of observation at his command, it is a matter for regret that Mr. Oates made so few notes upon the bionomics of the species he collected. For it is no exaggeration to say that if records had been kept in the case of each species of its habitat, and method of courtship and of the structure of its cocoon and snare, the value and interest of the collection would have been greatly enhanced. In the case, however, of *Herennia multipuncta*, an Epeiroid allied to *Nephila* and *Argiope*, and widely distributed in the Oriental region, Mr. Oates made the following observation :

"Makes a web about three feet long on a smooth tree-trunk, width one-third or one-fourth of girth of tree. All the lines are vertical or horizontal, forming a perfect rope-ladder. The web follows the convexity of the trunk, and is everywhere about half-inch from it. Verticals about one inch apart, horizontals about quarter of an inch apart."

With justice does Thorell term this : "annotatiunculam magni momenti," and add "rete formæ adhuc plane ignotæ igitur facit, *Herennia multipuncta*"! Curiously enough, however, M. Simon asserts that this same species, as observed by him in Ceylon, makes a snare, as indeed one would have supposed to be the case, of the ordinary orbicular type. We are consequently at a loss to know quite what value is to be attached to Mr. Oates's statement.

Turning to the spiders themselves, perhaps the only one amongst the new genera and species that calls for special mention is the remarkable new form *Prolochus longiceps*, which although presenting many points of similarity to the familiar epeiroid, *Meta segmentata*, differs from all the orb-spinners that have been hitherto described, in having only six large eyes and the cephalic region of the carapace very high and long. In this last respect it somewhat resembles the spider named *Archæa*, which was described by Koch and Berendt from the Oligocene amber beds of the Baltic. Thorell consequently refers it, although provisionally, to the Archæidæ (written by him Archæoidæ), and classes the family with the Retitelariæ, although for what reason does not appear. Probably the best way of disposing of the difficulty would have been the establishment of a new family for the reception of this anomalous spider.

So far as the rest of the genera and species are concerned, there appears to be nothing particularly remarkable in the collection, excepting only the new genus of Attidæ named *Ligdus*, which in its flattened form and the position of its enlarged first pair of legs presents a strongish superficial resemblance to one of the False-Scorpions (*Pseudoscorpiones*).

Most persons who glance through this book will probably be surprised and disappointed to find that the 400 pages of letterpress are relieved by no illustrations ; but those who are familiar with the rest of Dr. Thorell's works, will know what they have to expect on this head. The lack of figures, however, is made good, as far indeed as is possible, by the fulness of the specific descriptions, which often run to more than two pages of print. Some, perhaps, may be disposed to think these descriptions are unnecessarily long ; but on such a point, Dr. Thorell's opinion is probably of greater value than that of any other person : and it is only fair to him to mention that, in addition to the description, a briefer diagnosis of each species is subjoined, so that the attempt to identify a species does not necessarily entail a large amount of fruitless reading. We greatly regret, however, the author's stern adherence to the practice of not compiling synopses of his species. For there is nothing like a carefully compiled synoptical table for bringing home to an author and his readers the essential characteristics of the species being dealt with.

In the introduction Dr. Thorell takes the opportunity of explaining his opinions upon some of the many vexed questions connected with zoological nomenclature. But although we find it impossible to agree with all that he holds, the views of such an accomplished linguist are worthy of the greatest attention, especially where questions of philology are concerned ; and we earnestly commend them to the notice of those who in the construction and adoption of zoological names wantonly violate every canon of etymology, until "it seems as if neither common sense nor the dignity of science can claim any rights against the whims, carelessness, or ignorance of certain authors." Speaking, for instance, of the adoption without alteration of ungrammatically formed specific names, Dr. Thorell says :

"It is an essential rule in the Linnæan system that the scientific names of plants and animals shall be in *Latin*, at least as to their form. Now as a great number of specific names consist of the genitive of personal proper names, that genitive should, when possible, be formed in analogy with the genitive of Latin names or other words of a similar form. The genitive, for instance, of Caligula,

Livius, and Catullus being *Caligulæ*, *Livii*, and *Catulli*, I cannot accept such specific names as *Doriai*, *Retziusi*, *Catulloi*, but consider that they should be corrected to *Doriæ*, *Retzii*, *Catulli*."

With regard to genera, Dr. Thorell considers that such terms as *Scorpio* and *Aranea*, cannot be used in a generic sense, because in the plural form they are applied respectively to the orders of Scorpions and Spiders. This view, however, is, we venture to think, untenable. For the terms were used by Linnæus generically before they were used ordinally; therefore, if it be considered necessary to change either the generic or the ordinal name, it is surely the latter that should be abolished. Moreover, in the interests of nomenclature it is more important that the generic name should be stable than the other. And curiously enough, Dr. Thorell, with apparent inconsistency, seems to take this view of the case when there is any clashing between the name of a family and of one of its genera. For he always, and we believe correctly, forms he family-names with the termination—oidæ, such as Lycosoidæ instead of the more usually accepted Lycosidæ. But he affirms that if there be a genus termed *Lycosoides* contained in the family Lycosoidæ, the latter name must be altered, and a new one constructed from some other genus, *e.g.* *Trochosoidæ*, be adopted. The practical application of this view has led him to abandon such ong-established family-names as Epeiroidæ, Thomisoidæ, Attoidæ ; but if it were to be consistently and universally adopted, it is clear that all the family-names now in vogue, and every successive substitute, might have to be changed and again changed *ad infinitum*.

One other point deserving of notice is Dr. Thorell's opinion that the priority of *species*-names should be reckoned from 1751, when Linnæus, in his "Philosophia Botanica," proposed and gave rules for his binomial nomenclature. Most zoologists now refer back to 1758, the date of the publication of the tenth edition of the "Systema." But Linnæus's disciple Clerck published in 1757 his classical work "Aranei Suececi," in which he describes and gives good coloured figures of about sixty species of Swedish spiders, with binomial names according to Linnæus's system, and no arachnologist can admit that these names ought to be rejected simply because they were published *before* the tenth or twelfth edition of the "Systema." Such questions as these, however, we may perhaps leave with safety and confidence in the hands of the two recently appointed bibliographical committees, from which so much is expected.

R. I. P.

COLOUR VISION.

Colour Vision: being the Tyndall Lectures delivered in 1894 *at the Royal Institution.* By W. de W. Abney, C.B., D.C.L., F.R.S. (late R.E.) Pp. ix. + 231, 8vo. (London: Sampson Low, Marston, and Co., 1895.)

CAPTAIN ABNEY has long been known as the authority upon the scientific measurement of colour, and his researches have naturally involved a continual attention to the problems of colour-vision. This, too, he has made the subject of measurement in numerous ways, and in observations extending over many years. The results of his work in the domain of colour-vision were systematically expounded by him in the "Tyndall Lectures" of 1894, and have now been recast in their present form. The volume, which is sumptuously printed in double-leaded type, is illustrated not only by numerous cuts and process-blocks, but by an excellent chromolithographic spectrum chart of the typical cases of colour-vision. It is worthy of the reputation of the President of the Physical Society, and constitutes a distinct addition to the literature of physiological optics.

The work, as published, is now arranged in chapters without reference to the original disposition of the subject-matter when delivered in the form of lectures ; and a very large portion of the book is devoted to the various cases of colour-blindness, both congenital and acquired, including the species of amblyopia due to excessive use of tobacco. In the opening chapter, which deals with the anatomy and physiology of the eye, the fascinating theory of the "visual purple" is mentioned, only to be at once dismissed as incompatible with the fact that that part of the retina which is most sensitive both to light and colour, the forea centralis, is destitute of the structures which alone contain the substance which possesses the purple reaction. The second chapter deals with the wave-lengths that correspond to the several colours of the spectrum, and with the apparatus devised by the author for producing any desired mixtures of spectrum tints for the purpose of colour-matching. The physical proofs that green is a primary colour because it cannot be made up by mixing any two other colours, and that yellow is not a primary because a yellow can be made by a mixture of two others, are given very clearly. On p. 24 the author remarks that "we are all familiar with the fact that there are three primary colours," whereas the fact is not that the colours are primary, but that the sensations are primary ; and he assumes, without any proof save that of indirect inference, that these primary sensations are three in number. Indeed, in another passage the admission seems to be made that the sensations which are primary are four in number.

Quoting from Prof. Michael Foster's epitome of Hering's theory of colour-vision, the author gives the following statement.

"The sensations caused by different kinds of light, or by the absence of light, which thus appear to us quite distinct, and which we may speak of as 'native' or 'fundamental' sensations, are white, black, red, yellow, green, blue. Each of these seems to us to have nothing in common with any of the others, whereas in all other colours we can recognise a mixture of two or more of these. . . . Hering's theory attempts to reconcile, in some such way as follows, the various facts of colour vision with the supposition that we possess these six fundamental sensations. The six sensations readily fall into three pairs, the members of each pair having analogous relations to the other. In each pair the one colour is complementary to the other, white to black, red to green, and yellow to blue."

Commenting on this theory as so stated, Captain Abney says that it should be described as "tetra chromic" (should it not be chromatic ?) rather than "tri-chromic," for as far as "colour" is concerned, the black-white sensation must be excluded But, surely

there is much more to criticise in so crude a presentation of the case. Is not brown just as truly a "native" or "fundamental" sensation as green or blue? Without an education it would be impossible to pronounce it to be a mixture of any other two of the "native" sensations. The writer would go further, and include amongst native sensations that of purple, the pure full purple so rarely occurring in nature. To him, indeed, violet suggests a mixture of blue and purple, while crimson suggests a mixture of the sensations of purple and red. Further, it is not strictly true of the six supposed native sensations connoted by the six names given above, that they are in each pair complementary to each other. The true complementary to yellow is violet, not blue; the true complementary to blue is orange, not yellow. The true complementary to red is not green, but blue-green or peacock; and the true complementary to green (full green) is not red, but a crimson tending toward purple.

In other parts of the work, Hering's theory is compared with Young's theory; and a really decisive point in favour of the latter is made on p. 136, where it is shown, from the experiments made on the gradual extinction of luminosity down to the tints that persist last when all others have become invisible, that the finality of disappearance in the case of persons of monochromatic vision is inexplicable on Hering's physiological assumptions.

Many other points in the work show acute observation. The remark that no colour-match can be accepted unless we know the portion of the retina used in the operation is an instance, for the match will be different if the portion used is the macula lutea instead of a larger area of retinal surface; while, again, the colour-vision at 10° obliquity differs even in the normal eye from that of the forea centralis. The instructions how to pick out from the spectrum tints those which excite sensations that are primary, on p. 93, though not too clearly expressed, are readily understood; and of great value to future workers. The experiment of producing the neutral or a-chromatic sensation of light by means of a glow-lamp under a shade of blotting-paper, is both novel and neat.

Unfortunately the author occasionally uses words and phrases in a special or technical sense of his own devising, and which he does not define. It is left to the reader to discover, if he can, what the meaning is. For example, on p. 112, the words "the extinction" are used not to mean the disappearance of the light, but to mean, apparently, the percentage degree to which the light has to be reduced in order to be practically imperceptible. Unless one finds out by some sort of intuition that the word is being used in this unusual sense, one is puzzled to read three pages further on that "if we multiply the extinction by the luminosity, we shall get what we want.' Indeed, the word "luminosity," used so often throughout the work, needs to be better defined; and it ought to be used, when defined, only in one sense. There are several passages in which the word occurs, where it is not evident whether the term "luminosity" refers to the number of candles per unit area (the sense in which one would speak of the intrinsic or specific luminosity of the crater of the electric arc, or of the flame of a lamp), or whether it refers to the illumination of a surface in terms of the illumination due to a standard light at a standard distance, or, lastly, whether it refers to the apparent luminosity as viewed by a person of possibly abnorma vision. Yet at the bottom of p. 115 we are told that the author has taken "the luminosity of the yellow light near D [in a particular experiment] as one amyl acetate lamp." Taken literally and grammatically, luminosity here means simply "one lamp" of a kind that is known to be equal to about 0·87 of a standard candle. The plaintive remark on p. 181, that the word "brightness" is misleading to some people who are uneducated, is a curious commentary on the use of a word that will mislead some who are not uneducated. In a certain "criterion by the luminosity method" (p. 182), red is placed beside white, and the subject is asked to say which he considers the *darker*. This is to avoid asking him (lest it should be misleading) which he considers the brighter. Does the word luminosity as here used mean anything more than brightness? Again, on p. 110 we read: "The spectrum was of such a brilliance that the intensity of the square patch . . . of the orange light (D) was exactly that of an amyl-acetate lamp, placed at one-foot distance from the receiving screen. Knowing this, the actual luminosity of all other rays of the spectrum can be derived from the curve of luminosity." In this passage, has not the word "intensity" precisely the same meaning as "luminosity"? And does not the word "brilliance" again mean the same thing? Would not the passage be exactly as clear if the word "brightness" had been used instead of the three different words in the places where they occur?

The most valuable part of the work is that which relates to colour-blindness, where, for the first time, there are given charts showing the degree of *apparent* luminosity (the qualifying adjective is the reviewer's) in different parts of the spectrum to persons having one or other variety of colour-blindness. One case, mentioned on p. 85, is of exceptional interest. This is the case of a person who, though he sees each of the three fundamental colours quite correctly, red as red, green as green, violet as violet, is relatively less sensitive to green than other persons of normal vision. "He is defective in the green sensation, although it is present to a large extent." Here is a person who certainly would be quite capable of doing duty as an engine-driver or as a seaman, perfectly able to distinguish green lights from red, but who yet would be condemned, if tested by the much over-rated method of Holmgren, as being colour-blind. Indeed, the least satisfactory part of Captain Abney's book is that wherein, in the face of this very case in which Holmgren's wool tests would unjustly condemn a man, he describes and praises the Holmgren method of testing colour-vision. There is not one word of warning as to its uselessness in such cases, or as to its misemployment by practitioners devoid of any training in the optical laboratory. Captain Abney says that he "is glad to say" that the Holmgren system has been adopted by the Board of Trade and by most of the railway companies in the United Kingdom. The pity is, that no one explains to those who have to use it how easily the coloured wool test may be (and actually is) misused, and how in certain cases, like that cited, its indications may inflict a serious injustice.

S. P. T.

SELBORNE ILLUSTRATED.

Natural History of Selborne, and Observations on Nature. By Gilbert White. With the Text and New Letters of the Buckland Edition. Introduction by John Burroughs. Illustrations by Clifton Johnson. Pp. xxiii., vi., 208, 231. (London and New York: Macmillan and Co., 1895.)

YET another edition of White's "Selborne" has been issued by Messrs. Macmillan; and there are really some points about it which fully justify its appearance. It is in some degree an *édition de luxe*, being printed in beautifully clear type on thick glazed paper, and arranged in two neatly-proportioned volumes, which are fully illustrated.

The text is that of the Buckland edition. There are no editor's notes to speak of, and such of the "Observations," which it was thought desirable to include, have been inserted at the end of those letters to the subject of which they have reference. We have had many annotated editions, both good and bad, and probably no new one would tell us anything more concerning the subjects White wrote of in, or serve to elucidate further, the famous letters. Recent research has brought to light additional materials for a biographical sketch of White; but apart from this, we are inclined to dread the overdoing of the annotating —for overdone it assuredly was in some editions.

In his Introduction, Mr. Burroughs considers the reason of the longevity of this "cockle-shell of a book." He concludes that it is like plain food, neither exciting nor cloying; that, written by a born countryman, it has a home flavour about it. We are attracted by its sound style, and that precious sense of reality breathed in his sentences; by White's infinite curiosity, and his caution in making sure of his facts. But Mr. Burroughs is not quite just in one passage; it was *honey* dew, and not *heavy* dew, which White thought proceeded from the effluvia of flowers, although he was equally wrong in his supposition of the origin of that substance. Nor do we think that White succeeded finally in persuading himself that swallows in their ability to hybernate in a torpid state, stood on the same footing with bats and "turtles." As late as 1784 he had gone no further than considering the hybernation of house-martins probable. White received many facts relating to migration from his brother at Gibraltar, and in one letter we find him arguing in favour of migration in general with Daines Barrington, who was "no great friend to migration."

It seems to us that in this Introduction, one great charm of the "Natural History of Selborne" has been lost sight of.

White lived in England's golden age of leisurely prosperity, and it is just this air of leisureliness and freedom from any signs of hurry and worry, which gives his book its great charm, as its accuracy gives it its great value. In those days the man of small property who lived in a retired part of the country had practically no demands on his time, beyond such as he chose to make for himself in the direction of his garden, his live-stock, and his house. Society, as we understand it now, must have been unknown at that time to those who did not go to town. It was not necessary for White to pay calls, or to go to functions. A little "neighbouring" in the village and its immediate vicinity at convenient times, and some visits exchanged once or twice a year with well-tried friends, fulfilled all demands of that kind, although, as we see from the letters to the Barkers, White was fond of filling his house with friends and relations. There were in those days no stirring "movements" on foot, for the edification of men and women in the abstract, to claim his philanthropic attention, though we may be sure the needy of Selborne were not forgotten. To be well-read meant that a man might read the classics and a few favourite authors at leisure, instead of struggling with the stream of new books, with its ever-gathering strength and volume. White had not to acquire a smattering of a dozen sciences and a superficial idea of art, or to assimilate eight pages of a daily newspaper in order to fit himself to meet his enemy intelligently in the gate. At Selborne he had perfect leisure, and could bring an intellect, unstrained by his leisurely studies, to bear in unhurried observation on the comparatively limited outdoor objects of his quiet parish. Doubtless he had trained his observing eye and mind, as so many have trained them, in his sportsman days; and the habit of keeping a careful diary fostered accuracy in a mind naturally exact. It was, we imagine, his love of Selborne which prompted the production of his book; for if he observed much elsewhere, he did not note down his observations. Had he done so, we should surely have found in his letters more frequent references to the period of his residence at Oxford, then comparatively a leisurely place itself.

Undoubtedly the chief attraction in the present edition is the illustrations. For the first time we have a set which give us an idea of what Selborne village and neighbourhood are like. It is true that it is Selborne a century after White's death, which is represented, but we imagine that there must be much that is but little altered. We should have valued a few contemporary views very dearly. As we write, we have been turning over the leaves of another copy of the "Natural History," "a new edition with engravings," issued in 1822, and edited by John White, of Fleet Street. But the only illustration of scenery it contains is a view of the "grotesque building constructed by a young gentleman who used on occasion to appear in the character of an hermit." Some years ago it was our pleasant fortune to meet a relative and namesake of the author, who told us that the original of this sketch was still in existence. If there are any more eighteenth-century Selborne landscape pictures available, how admirably they would have embellished this edition! The illustrations in the two volumes, the subject of this notice—chiefly reproductions from photographs—will be heartily welcomed by those who love the book. Those who have made their pilgrimage will value them as a souvenir of their visit, while those who cannot go to Selborne will now have its quiet scenery brought to them. Though many changes have come to Selborne in the last hundred years, yet there must be some things left very much as White saw them. His house and his garden do not appeal much to us in the pictures, nor does the interior of the church, which seems to have suffered restoration, but we are very glad of his old sun-dial. Rick-building is a thing likely to be carried out conservatively in the local fashion,

while thatching is a rural fine-art handed down mostly from father to son. So it is probable that the corn-rick in Norton farmyard (p. 54) is similar in make and shape to that, for instance, under the thatch of which "were assembled near an hundred" harvest mice; although most probably in White's time all the ricks were erected on "staddles." The rick in the illustration is unlike the oblong square ones usual in some districts, and the round ones prevailing in others; it is square, and has the corners neatly rounded. There are some excellent views of the irregularly shaped thatched cottages, which are probably but little altered, and possibly the same may be said of the substantially-built houses seen when looking across the Plestor. The Plestor, the famous wooded "Hanger," and the Long Lythe—a favourite walk of White's—are quite familiar scenes in the mind's eye of White's readers. Views of Wolmer Pond and Wolmer Forest, once the haunt of wild red deer and black game, and where White found teal breeding, which he looked upon as "a great stroke in natural history," are very suitable illustrations, and we are charmed to have a picture of one of the "little round ponds" on the sheep-downs, which never dried up. But why insert a view of Stonehenge? White certainly mentions it; but so he does Oxford, Calabria, and other places which have nothing particular to do with Selborne. The figure of the "Rook-starver" (Rook-scarer) suggests the question whether this was a name of White's day. Most of these curious local names are old; but the Hampshire villagers must have differed from those of the Midlands, for instance, who invariably call rooks crows, and talk about "Crow-keeping." One of the prettiest views is that of an old cottage in the Lythe backed with clumps of hanging wood, and there is a very nice picture of a rookery.

There are a good many illustrations of birds, which in some, if not all, cases seem to have been reproduced from photographs of stuffed specimens. With hardly an exception they are quite as unsatisfactory as illustrations of this kind usually are, and some of them are exceptionally bad.

In the present edition the arrangement of the letters to Pennant and Daines Barrington in two separately numbered series is departed from, the whole being fused and arranged chronologically; this, especially to those used to the other style, makes the want of an index more felt. The second volume concludes with the new letters to members of the Barker family, and the Calendar.

O. V. APLIN.

PLANT PHYSIOLOGY.

Das Pflanzenphysiologische Prakticum. Von Dr. W. Detmer. Mit 184 abbildungen, zweite völlig neu bearbeitete Auflage. (Jena: Fischer, 1895.)

IN the new edition of this standard book, the general arrangement of the first edition has been for the most part adhered to, but in other respects great changes have been made. Nearly every section has been re-written and enlarged, a large number of new experiments have been added, and in every case great care has been taken to give full details for carrying out the observations described. Among the sections added, the following may be mentioned: on the relation of the stomata to assimilation; an account of experiments on species of the natural family Papilionaceæ, illustrating their relation to the bacteria normally found in their roots; on nitrification, including an experiment on nitromonas, one of the remarkable organisms capable, without the action of light, of forming organic substances from inorganic materials. Another addition is the section on mykorhiza. In dealing with the intercellular system of plants, it is strange that Prof. Detmer still quotes the intercellular space, which accompanies the bundles of *Zea Mays*, as an example of a passage which is of importance in the exchange of gases and the aëration of the tissues; while it is almost certain that this passage is chiefly serviceable in conducting water in the plant. The sections dealing with transpiration have been materially enlarged and improved, although it is difficult to see how the author could be inclined towards Westermaiers and Godlewski's theories after Strasburger had so completely answered them. It is to be noted that, in an appendix, Prof. Detmer appears to accept the theory which regards the upward motion of the sap as due to the tension set up by the evaporation taking place in the leaves, and transmitted downwards through the water-columns in the tracheidal system. He, however, apparently by an oversight, attributes this theory to Prof. Askenasy, who himself, in the paper describing the theory, acknowledges the priority of its English authors.

In treating of the development of heat and phosphorescence by plants, much new matter has been added. The raising of the temperature of flowers above that of their surroundings, is doubtless often an attraction for their insect visitors; and it appears strange that phosphorescence should not be made useful in the same way, and that while many of the lower plants exhibit this phenomenon, yet in the flowering plants authentic instances of phosphorescence under normal conditions seem to be unknown. *À priori* we might consider that phosphorescing flowers would be very efficient in attracting night-flying insects for purposes of pollination, especially as this method of arresting attention is shown to be successful by several instances in the animal kingdom.

The portion of the book allotted to the movements of plants in response to stimuli, is clearly written, and contains accounts of much recent research in this field of plant physiology. Illustrating this subject, there is plenty of material for beautiful and striking experiments; perhaps one of the prettiest, described by the author, is an experiment on the chemotropism of the pollen-tube. A leaf of Tradescantia is injected with a sugar solution, and afterwards quickly washed in water and dried on the surface. On the under surface, which is rich in stomata, a number of pollen-grains are scattered, and the leaf thus treated is kept in a damp chamber. After a certain time it may be observed that the tubes of the germinating pollen-grains are each directed towards some one of the stomata, showing that the sugar solution in the stoma, and the intercellular spaces connected therewith, induces a chemotropic movement in the pollen-tube.

In its new form the book is certainly one of the most complete, if not the most complete, text-book of plant physiology. For although it is much smaller than Sachs'

classical "Lectures," yet it is so concise, that there is room in it to describe as many or more experiments than in the latter book; and it contains a great amount of recent work, which is naturally not to be found in the older text-book. The conciseness has, of course, its disadvantages, for in consequence of it the book is not so readable, nor is there space for the same philosophical treatment of the subject which is characteristic of the work of Sachs. Much, however, is done to lessen these necessary drawbacks by the clearness of the arrangement and the descriptions, and references to the original papers are in most cases given, so that the reader is presented with much of the literature on each subject. From these references the names of English authors are almost completely absent; this is in part due to the fact that, unfortunately, so few of our countrymen occupy themselves with plant physiology, and in part to the fact that, even when such work is to hand, the author often fails to allude to it.

Finally, the usefulness of the book is increased by a very complete index; and we are glad to learn that an English edition is in preparation. H. H. D.

OUR BOOK SHELF.

Science and Art Drawing: Complete Geometrical Course. By J. Humphrey Spanton, Instructor in Drawing, H.M.S. *Britannia.* Pp. 582, and 689 figures. (London: Macmillan and Co., 1895.)

THIS is a somewhat bulky but handsome well-printed volume, the title of which is a little unfortunate; it should, however, prove useful to students preparing for such examinations as those of the Science and Art Department, for the Army, or for Cooper's Hill. The author takes as a basis the South Kensington syllabus, and, by sundry additions, covers nearly the whole ground necessary for other examinations. The book is a trifle paradoxical, for while in the solid geometry information abounds, in the plane geometry the opposite is the case, and generally anything approaching to an explanation of the principles underlying the constructions has apparently been eliminated. This, we think, is a matter for regret, as a much larger sphere of usefulness would be obtained by a few judicious explanations, or by an occasional reference to Euclid; indeed, a step further might well be taken, and the equations of curves be given. The student would thus be familiarised with mathematical formulas, and by a little instruction would be enabled to follow the *rationale* of the construction instead of simply learning it by heart; for instance, the equation, $r = a + b \operatorname{cosec} \theta$, of the conchoid of Nicomedes (p. 183), shows at once the reason for the given construction being adopted. Such additions need not necessarily make the book more bulky, as the drawings on pp. 31–34, 60, 61, 78–80, and 164 might well be omitted.

The figures, which must of necessity form a distinctive feature in a work of this nature, are good throughout; those for the plane geometry, however, suffer by comparison with those of the remainder of the book, as the lettering of the former is not by any means neat; also, some of the diagrams illustrating horizontal projection are too small. For exhibiting the conic sections to junior students, the author hits on the happy method of cutting off, from the light of a candle, a cone of rays by means of a circular hole cut in a sheet of cardboard, and then by inclining another piece of cardboard across the cone the various conics are produced in shadow; later on, the conics are again discussed in an instructive manner as the sections of a cone. The author is not always fortunate in his definitions, and ambiguities occasionally occur; for instance, the spheroid (p. 13) is defined as "resembling the sphere in shape, but all its sections are not circles." Again with the conchoid (p. 183), we are told that "it has the *peculiar* property of always approaching nearer a straight line as it is produced, but would never meet it." From this it would almost appear that an asymptote occurred with the conchoid only, as it is never mentioned elsewhere, not even in connection with the hyperbola.

In the solid geometry the interest of the student is first excited with the plan and elevation of the simple solids; then a good chapter on spheres and spherical triangles is incongruously wedged in between this and the following chapters on points, traces of lines and planes, intersection of solids, &c.; the author faithfully following the South Kensington syllabus (omitting, however, any reference to perspective), and finally closes with elementary graphic statics, in which, by the way, a slight error has occurred in Fig. 331, the component (q) being shown in the wrong direction. The pages are remarkably free from error, and the book will no doubt fulfil a want felt by many for a practically complete course.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Discovery of the Anti-Toxin of Snake-Poison.

I DESIRE, without offering any comments on the facts, to bring under the notice of your readers the following simple statement.

In the *Annales de l'Institut Pasteur*, May 1894, Dr. Calmette described in full detail his researches on snake-poison, and demonstrated that not only can animals be rendered resistent to cobra (and other snake) poison by the injection into them of graduated doses of the poison (so that rabbits were rendered tolerant of sixty times the lethal dose), but that the serum of such immunised rabbits is found to contain a powerful anti-toxin which can be used successfully as an antidote to snake-poison. In April 1895, in the same *Annales*, Dr. Calmette described the results of a year's further work on this subject, giving the most important facts as to the antidotal action of snake anti-toxin in regard to poisons allied to snake-poison, and of other anti-toxins in regard to snake-poison.

On both occasions Dr. Calmette formulated his discoveries in such a way as to render them applicable to the treatment of snake-bite in man.

On June 3, 1895, Prof. Thomas R. Fraser, of the University of Edinburgh, read to the Royal Society of Edinburgh a paper (subsequently printed in the *Proceedings* of that Society) "on the rendering of animals immune against the venom of the cobra and other serpents; and on the antidotal properties of the blood-serum of the immunised animals."

In this paper, read more than a year after Calmette's first paper above cited was published, Prof. Fraser has refrained from any textual reference to Calmette's published work. His only mention of Calmette is as follows: "Within the last few months, Phisalix and Bertrand have obtained experimental indications of the antidotal power of the blood-serum of animals immunised, but only to a low degree, against the venom of vipers; whilst Calmette, working in the Pasteur Institute of Paris, after several unsuccessful endeavours had led him to express the opinion that immunity against snake-venom could not be produced, afterwards succeeded in obtaining evidence of its production, and of the power of the blood-serum to counteract the effects of venom."

The medical journals of Great Britain have represented Prof. Fraser as the discoverer of the anti-toxin of snake-poison. Two distinguished Edinburgh biologists—Prof. Geddes and Dr. Arthur Thomson—writing on Pasteur in the *Contemporary Review*, have put forward Prof. Fraser as one who has made an important life-saving discovery which is the latest fruit of Pasteur's fertile conceptions.

As a matter of fact, any one who will take the trouble to read Dr. Calmette's papers and Prof. Fraser's, will find that the sole credit of discovery in this matter rests with Dr. Calmette, who worked under the direction and with the suggestions of Dr. Roux.

It would be interesting to know whether the *Annales de l'Institut Pasteur* are accessible to Prof. Fraser, and whether he thinks that his vague reference to Calmette's detailed researches, and his designation of the interval between May 1894 and June 1895, as "a few months," are calculated to give to the British public a fair notion of the merit in this matter of his French colleague.

E. RAY LANKESTER.

Oxford, November 28.

The Maerjelen Lake.

A CORRESPONDENCE which I was recently the innocent cause of initiating in the *Standard*, revealed a very remarkable conflict of evidence touching the question of how often and to what extent the Maerjelen Lake[1] has of late years emptied itself. As I pointed out, the rare phenomenon of a total discharge of the lower basin through the Aletsch glacier recurred last September; whilst in the great majority of cases, a pool more or less deep is left in that basin, and the upper, more shallow basin is never quite empty.

Considering the grandeur of the emptying of the lake as an Alpine phenomenon, it might reasonably be expected that those who are fortunate enough to witness it, would take the trouble to note the dates and facts accurately. Such, however, is rarely the case, for many eye-witnesses are so led away by their enthusiasm at the time, and so deceived by their memory afterwards, that their evidence is often flatly contradictory, and hence of little or no value. This is strikingly illustrated by the public correspondence referred to, as well as by private letters and other information I have received since.

It would lead too far to enumerate all the vague and contradictory statements, both as regards dates and facts. Suffice it to mention that, while some eye-witnesses infer a total emptying of the lake simply from having seen a rush of water along the surface of the Aletsch glacier, others draw the same inference from the fact that they saw the lake empty. But neither of these inferences affords proof of a total discharge; for in the first case, only a partial discharge may have taken place, such as last occurred in September 1894, and in the second case, the lake, unless it was seen full the day or a few days before, may have been partially or completely empty for months. A partial emptying is of frequent occurrence; but the only true test of a total discharge, as authentically recorded, *e.g.* in 1864, 1878, 1887, and 1895, is the exposure of the glacier wall to its full depth of at least 150 feet immediately after the event. Some years ago, Prof. F. A. Forel gave a list of the recorded discharges (without special reference to partial or total discharges) up to 1890);[2] but even that list cannot, and, I believe, does not lay claim to completeness and strict accuracy.

The occurrence of September this year is of peculiar interest, because it shows that, notwithstanding the recently completed artificial overflow tunnel to the Viesch glacier, the Maerjelen Lake prefers its old outlet through the Aletsch glacier.

C. S. DU RICHE PRELLER.

The Former Northward Extension of the Antarctic Continent.

I SHOULD not presume to draw the attention of your readers to this much-discussed topic without having a new fact to contribute. The opportunity of loading still further the already overweighted scale which now dips so deeply in favour of the notion of a former northward extension of the Antarctic continent, has been afforded me by the kindness of Prof. Parker, F.R.S., of Otago, New Zealand. He has forwarded to me a few worms collected in Macquarie Island, which lies to the south of New Zealand, about half-way between it and the land of the southern continent. These belong partly to the almost worldwide *Pachydrilus*, and one species—a new one—is referable to the earthworm genus *Acanthodrilus*. The importance of this latter species is that it is firstly an *Acanthodrilus*, and secondly that it is closely allied to a group of Patagonian and South Georgian species of the same genus, and is less like any New Zealand form. It is to me a matter of surprise that Dr. H. O. Forbes, in his recent and important essays upon this question, has ignored the distribution of earthworms, which are so thoroughly wedded to the soil, and (except in a few cases) so impatient of sea-water. I have attempted to rectify this state of affairs in a text-book of zoogeography, lately issued by the Cambridge University Press. In Patagonia and some of the islands immediately to the southward, only two genera of indigenous earthworms, so far as is known at present, exist. These are *Acanthodrilus* and *Microscolex*. Of the former there are nine species, and of the latter five; but five species of *Microscolex* and two species of *Acanthodrilus*, in addition to those referred to, range northwards into Chili, which zoologically is indistinguishable from Patagonia. Let me emphasise the point that these are the only two genera which occur in these latitudes, save for a species or two of the European *Allolobophoba*, which is universal in range—thanks probably to direct exportation by man. In Kerguelen and Marion Islands but one species of earthworms has been found, which is an *Acanthodrilus*. In New Zealand there are nine species of *Acanthodrilus*, also six species belonging to genera that are very nearly akin to *Acanthodrilus*, and three species of *Microscolex*. The remaining six species of *Microscolex* are South and Central American to the extent of four, while the two remaining are from Tenerife and Algeria. Of *Acanthodrilus*, the only species left, after deducting those already enumerated, are one from the Cape of Good Hope, one from New Caledonia, and three from Western and North Australia. Besides these forms New Zealand possesses a single Perichætid worm and Schmarda's species, *Hypogæon orthostichon*, which I have recently (a "Monograph of the Order Oligochæta," Oxford, at the Clarendon Press) referred to the characteristically Australian genus *Megascolides*. It is clear that, if the former northward extension of the Antarctic continent is not believed, some explanation of these remarkable facts is much wanted; on that hypothesis they are perfectly explicable.

FRANK E. BEDDARD.

Zoological Society's Gardens.

The Feeding Ground of the Herring.

I HAVE no desire to set aside lightly the observations of Profs. Herdman, Brady, Scott, or any other scientific gentleman, as suggested by Mr. Calderwood in your issue of November 21. There is no evidence that these gentlemen have made any systematic examination of the deep waters of Loch Fyne, whereas I have carried out investigations of this kind during many years at all seasons under the direction of Dr. Murray and Dr. Mill, and I think Prof. Herdman set these observations very lightly aside in his Ipswich address.

If various kinds of tow-nets be dragged through the surface waters of Loch Fyne, down to a depth of 20 fathoms, at the present time of the year, probably not a single specimen of red-coloured *Calanus*, *Euchæta*, *Nyctiphanes*, or *Boreophausia*, will be captured, and these animals I hold make up nine-tenths of the bulk of the food of the herring in Loch Fyne. If the same nets be dragged near to the mud at the bottom in depths between 70 and 100 fathoms, immense numbers of these Crustaceans will be taken; and this state of matters practically holds good throughout the whole year, these Crustaceans being always found at the bottom and rarely at the surface. It occasionally happens, however, that at quite local spots some of these deep-sea Crustaceans rise or are drawn up to the surface, and being carried out of their natural habitat are killed there, and are blown upon the shore, where they form a red line along the beach. It must be remembered, however, that this is quite an exceptional occurrence. On several occasions we wished to send to Inveraray living specimens of *Nyctiphanes*, in order that their brilliant phosphorescence might be exhibited. These were captured in large numbers in the trawl sent down to 70 fathoms, but we found that they were all killed as soon as they were put into the jars, which we afterwards found had been filled with the somewhat fresh water floating on the surface of the loch; it was only by collecting water from the deeper layers that a few specimens could be preserved alive. On other occasions, after a long spell of dry weather, there was no difficulty in keeping large numbers of *Nyctiphanes* alive for a long time, and on one occasion I conveyed many bottles filled with these Crustaceans to Edinburgh, and exhibited them at an evening meeting of the Royal Society.

The very fact that Mr. Calderwood was able to scoop up red-

[1] *Vide* NATURE, 1887, vol. xxxvi. p. 612. T. G. Bonney.

[2] "Variations Périodiques des Glaciers des Alpes." S. A. C. 1890, p. 358.

coloured *Calanus* on the beach with his hand, shows that these creatures had passed through some unfavourable conditions. Dr. Murray has endeavoured to show that these deep-sea animals are brought to the surface through the movements of large bodies of water during gales or during calms following gales. However this may be, their proper habitat is certainly at the bottom. When they do come to the surface they form oily-like streaks or small spots, where herrings and other fish and birds may be seen feeding upon them. The *Nyctiphanes* at any rate remain but a very short time at the surface. On one occasion in Kilbrennan Sound we were attracted to a spot where guillemots, gulls, and other birds were feeding, and we found that their stomachs were filled with perfectly fresh *Nyctiphanes*, and the *Nyctiphanes* themselves could be distinctly seen on the surface for a short time. The fishermen shot a circle trawl-net around this spot, and procured twelve boxes of herrings, the stomachs of which were distended with these Crustaceans in all stages of decomposition. I can show these stomachs to any one visiting this Station.

In my previous letter I mentioned that we had captured herrings in the deep water with their stomachs filled with these Crustaceans, and skate, which feed at the bottom, have been taken in depths over 50 fathoms with herrings in their stomachs. When the herrings' stomachs are filled with adult *Nyctiphanes*, as above stated, the herrings are not commonly called "gut-poke," or at least are not looked upon as diseased. The so-called disease is attributed to those herrings which have been feeding chiefly upon the young *Nyctiphanes*, or "black-eye."

I do not claim that there is anything new on this subject in my letters, nor do I see anything new in that of Mr. Calderwood, except the statement that Copepods alone are the cause of the the so-called "gut-poke" disease, which I do not believe. The whole of this information was published many years ago. In a lecture delivered in November 1887, as reported in the *Scotsman* of November 23, Dr. Murray said regarding the "poke-gut":—

"There was also a kind of herring called the 'poke-gut' herring, which was supposed to be suffering from some disease or complaint. This was a herring whose stomach was distended with food, which consisted of one or other of the minute animals to which he had referred. One of the commonest things to be told on the west coast was that the 'poke-gut' herrings were not fit for food, and would not cure. The fishermen told them that they had eaten some 'black stuff,' the effect of which was to make them sick, that it burned a hole in their bodies, and acts as if they had eaten quicklime. For a long time he was very doubtful as to what the explanation of this belief could be, but he ultimately found that the cause of it was this—that the poke-gut herrings had been feeding on the young *Nyctiphanes*. The eyes of these creatures are very black indeed (as Dr. Murray showed by exhibiting a bottleful of the creatures in a preparation of glycerine), and an accumulation of these in the stomach of the herring gave the whole contents a very black aspect. On being taken into the boat, decomposition set in very rapidly, the lining of the stomach was speedily eaten away, and before long an actual hole, as the fishermen said, was made in the body, out of which this black mass exuded. In this 'poke-gut' state the herring, however, was simply engaged in laying up a store of fat, the nutritive processes of the animal being then exceedingly active. When it had laid in this store of fat, the herring then sought the shallow waters of the shore for the purpose of depositing its spawn. Mr. Hoyle spent several months at Peterhead examining the stomachs of the herring to ascertain what they fed upon during the fishing season, but the result of his investigations was that he did not find in any one of them a full meal. Similar results were obtained by Mr. Beddard at Eyemouth, and by Prof. Herdman on the coast of Arran."

Our observations on board the *Medusa* went to show that the "poke-gut" condition of the herring was chiefly due to the large number of young *Nyctiphanes* contained in the herrings' stomachs, but Mr. Calderwood makes no mention of any Crustacea beyond Copepods. ALEXANDER TURBYNE.

Scottish Marine Station, Millport, Cumbrae, November 29.

The Theory of Magnetic Action upon Light.

I HAVE already pointed out that the various questions relating to the theory of the action of magnetism upon light cannot be disposed of by arguments based upon vague and obscure general reasoning, but require a careful mathematical investigation for their elucidation. I therefore propose in the present letter to state, as briefly as possible, the results to which an examination of Mr. Larmor's theory leads, and to show how my own theory may be amended so as to remove the objection concerning the discontinuity of the E.M.F at an interface.

I find that Mr. Larmor's theory requires that all the equations of Maxwell's general theory of the electro-magnetic field should remain unaltered, except the equation

$$P = -\dot{F} - d\psi/dx,$$

which must be modified by the insertion of the additional terms

$$-p_3\dot{g} + p_2\dot{h} + z\,d\phi/dy - y\,d\phi dz \;.\;.\;.\;.\;.\; (1)$$

where p_1, p_2, p_3 are constants depending on the magnetic field, and ϕ is a potential function.

The first two terms are equivalent to introducing Hall's effect; but for the last two there is no justification whatever. They are not required in optics nor in electro-magnetism. These results, combined with Larmor's boundary conditions, prove my statement that his theory makes the tangential component of the E.M.F. *discontinuous* at an interface.

In the next place, a satisfactory theory may be constructed by modifying Maxwell's relation between E.M.F. and electric displacement, keeping all the other equations unaltered. The proposed modification is

$$P = 4\pi f/\kappa + p_3\dot{g} - p_2\dot{h} \;.\;.\;.\;.\;.\;.\;.\; (2)$$

It will be found that this hypothesis leads to exactly the same equations of motion and boundary conditions as those given in my paper in the *Phil. Trans.*, 1891; but that, in consequence of the relation (2), the tangential component of the E.M.F. is *continuous* at an interface. The other boundary condition is, continuity of the tangential component of the magnetic force.

According to Maxwell's theory, the electrostatic energy is given by the expression

$$\tfrac{1}{2}(Pf + Qg + Rh);$$

and if we assume that this result holds good when P is given by the modified form (2), it will be found that all the results can be deduced by means of the principle of least action.

Under these circumstances, I think I may justly claim to have placed the theory of Kerr's experiments on as perfect a basis as is possible in the existing state of electrical science.

A. B. BASSET.

Fledborough Hall, Holyport, Berks, November 29.

The Barisál Gun.

I HAVE read with interest Dr. Darwin's communication, in NATURE for October 31, on "The Barisál Guns and Mist Pouffers," and his request that the readers of your journal should give accounts of their own experiences in this matter. I refer him to the *Theosophist* magazine, vol. ix. p. 705, and vol. xi. p. 409, for two articles upon my personal observations at Barisál village itself, in the Gangetic delta. All the various theories until then propounded by men of science to account for the phenomenon in question were severally reviewed and pronounced inadequate. I had intended writing a third and final article, but found it impracticable to throw any further light upon this most interesting problem, and so abstained. Dr. Darwin is quite wrong in supposing that the sound of the "Barisál Gun" is "dull and distant," and that "it does not resemble artillery." However the like sounds may seem to the Ostend lighthouse-keeper, they were so sharp and loud that I thought the "evening gun" was being fired at a cantonment in the village, and asked a friend standing by if that were so. I shall not encroach on your space to go into details, since the back volumes of the *Theosophist* may be consulted at the British Museum, and Dr. Darwin will make such use of them as he sees fit. H. S. OLCOTT.

Adyar, Madras, November 20.

Remarkable Sounds.

IN connection with Profs. McKenny Hughes and J. P. O'Reilly's letters on the above subject, suggesting the collection of data as to the distance the sound of blasting, &c., has been heard, it may be interesting to state that the blasting operations in the Charnwood Forest quarries (probably Bardon Hill) can be distinctly heard on the higher ground to the south-west of Atherstone, a distance of about eighteen miles. From the intensity of the sound, I have little doubt that under favourable conditions it may be heard very much further.

Geological Survey, Leicester. C. FOX-STRANGWAYS.

Flight of Birds Across the Moon's Disc.

ON the evening of October 7, 1895, while observing the passage of the moon through the Pleiades for occultations, my attention was attracted by a flight of birds across the moon's disc. This continued with more or less regularity the whole time I was at work, from 7.30 to 9.30, the birds usually crossing singly, but sometimes in groups of two, three, or even four. In all, I saw perhaps 50 or 60; assuming a like frequency during the intervals when I was not at the telescope, from 200 to 250 must have crossed the disc during the two hours. All were flying south with a single exception. Their outlines and the flapping motions of their wings were very distinct; none were soaring. The telescope is a 12-inch refractor: eyepiece of power 90. The moon was low, its altitude ranging from 5° to 15°.

The time occupied in transit varied from four to eight seconds, the difference in apparent size being very marked, and the larger always taking the less time. Assuming a rate of twenty miles an hour for their flight, the distance would be about 5 miles for a bird making a transit in eight seconds, or 2½ miles for four seconds. Taking into consideration the altitudes of the moon when the above transits were timed, the corresponding altitudes of the birds above sea-level ranged from 2700 to 5000 feet. Considerations as to its size make it probable that these figures are none too small. It may be of interest to note that the Observatory stands on a promontory jutting out about 5 miles from the general trend of the Syrian coast, and that according to these calculations the birds were flying either just along the coast-line or over the sea.

I may add that, in addition to Mr. Bray's experience, given in NATURE, No 1348, several accounts of similar observations are given in Newton's "Dictionary of Birds," with estimates of altitudes, ranging, for the most part, much higher than those given above.

ROBERT H. WEST.

Syrian Protestant College, Beirut, November 25.

A Luminous Centipede.

RETURNING home on a very dark evening a few days ago, I saw on the ground a greenish phosphorescent light which, in the distance, I took to be a glowworm (*Lampyris noctiluca*), but a nearer approach showed a luminous thread-like worm of 1¼ inches in length, moving in curves along the gravel drive. I stooped and placed a finger and thumb on either side of the glowing thread without actually touching it, and in a few seconds observed that, aware of danger either from scent or vibration, the insect showed a remarkable power of control over its luminosity, invaluable for protection. It began to extinguish its light, and in a most peculiar fashion, not dying slowly out all over, but with a rapid wave of darkness sweeping from the tail to the head, then in a second or so glowing brightly all over again, repeating the manœuvre several times so long as my finger and thumb remained in its vicinity. A glass was brought, into which I transferred the insect, where it glowed with a lessened light for three or four hours. The next night the phosphorescence was very feeble, and on the morning following the insect was dead.

Seen in the daylight my capture appeared to be a thin thread-like centipede, orange-coloured, furnished with a fringe of fine hairs on either side of its many-segmented body.

ROSE HAIG THOMAS.

The White House, Basildon, November 27.

THE above communication certainly refers to one of the luminous centipedes of the family *Geophilidæ*; and since the species that most commonly draws attention to itself in England by the exhibition of phosphorescence is of a reddish-orange colour and is known as *Linotænia crassipes*, there is no reason to doubt that the specimen under discussion was an example of this species. The property of luminosity lies in an adhesive fluid secreted by glands which open upon the lower surface of the body, and the power of discharging or retaining the fluid appears to be entirely under the centipede's control.

The phenomenon is observable during the autumn months, from about the middle of September to the end of November, and although its significance is not clearly understood, it is generally believed to be connected with the pairing of the sexes.

R. I. POCOCK.

The Critical Temperature of Hydrogen.

IN the October number of the *Proc. Phys. Soc.*, Mr. "G. H. B.," after quoting Wroblewski's paper "Die Zusammendrückbarkeit des Wasserstoffes" (*Wiener Sitzb.*, 1889), says (referring to my paper "On the Critical Temperature of Hydrogen," *Bull. Acad. Cracovie*, March 1895): "Natanson does not appear to have made any fresh experiments on the subject, and the conclusions arrived at in his paper are therefore not results of independent original investigation." It is difficult to understand the right Mr. "G. H. B." has to ignore the professedly *theoretical* character of my paper. To blame a writer offering theoretical deductions on the account of his not having made "fresh experiments," is surely a criticism of extraordinary character. Wroblewski's critical data are not in the least the outcome of direct experiment, but have been calculated from an empirical equation, constructed to represent Wroblewski's compressibility curves. My reasoning and calculation are *utterly different*, being founded upon Van der Waals' law of thermodynamic correspondence. Besides, there are other points in my paper, and they have no relation with whatever Wroblewski has written. All this will be seen at once on comparing my paper with that of Wroblewski's. But from Mr. G. H. B.'s own words, it must be inferred that, before publishing what implies a serious accusation, he did not take the trouble of looking with his own eyes at Wroblewski's paper.

LADISLAS NATANSON.

Cracow University, November 28.

A METEOR PHOTOGRAPH.

THE accompanying photograph (p. 132) was obtained on Saturday night, November 23, about 12h. 15m., by Mr. C. P. Butler, at Knightsbridge. With the intention of focussing and testing the field of a new lens, he had placed a quarter-plate camera on the window-sill, pointed it roughly at the region near the boundaries of Perseus, Andromeda, and Aries. He was necessarily in darkness during the exposure, but uncovered the plate about 12h. 10m., and terminated the exposure at 12h. 20m., so that the limits are close enough for recognising the meteor if it chances to have been recorded elsewhere, On developing the plate on the following Monday, the track of the meteor was the first impression to be perceived, and, not knowing of its occurrence during the taking of the photograph, it was thought that the plate had by some mishap been spoiled. Having finished developing, however, and after fixing, it was seen that this was not the case, the strange appearance being evidently an image of some meteor flashing past during the exposure. The star trails (the camera was fixed, so the stars are represented by short lines about an eighth of an inch long) are all distinct, but owing to the region included in the field being almost barren of bright stars, with the exception of α, β, and γ Arietis, which come in at the edge of the plate, they are too minute to bear reproduction.

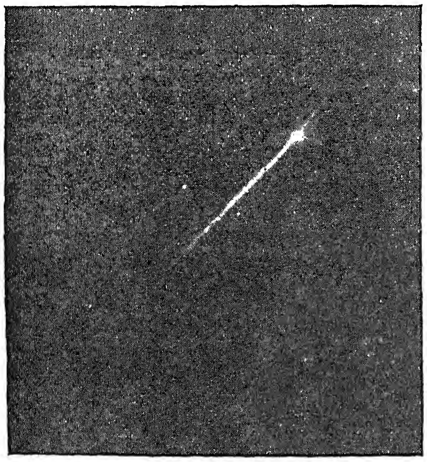
Confirmation of the occurrence of the meteor is given by its having been observed from the South Kensington Observatory, both the time of fall, 12h. 15m., and the estimated region of its path being identical with the above observations.

As near as can be estimated, on consulting the region on the star map, the meteor appeared some distance south of the interval between Perseus and Aries, in the area enclosed by α, γ, ξ^2 Ceti, and fell downwards. It would probably be one of the Andromedes, which were due to occur on the 23rd ult.

It was described as being as bright as Jupiter, and leaving a long trail. This is fully borne out on carefully examining the negative, or the accompanying enlargement, which is about six times the size of the original. Much additional light is thrown on the phenomena attending the passage of a meteorite through our atmosphere, as at present all that is known rests on the results of visual observations, which may be greatly deceptive in the case of such rapidly-moving objects.

The image, in comparison with those of stars of known

magnitude, proves the body to have been at least of magnitude -1, and at the time of greatest brilliancy this s probably an under-estimate.



PHOTOGRAPH OF A METEOR.

It begins very faintly, showing the initial contact with the atmosphere, and, gradually increasing in brilliancy until it has travelled about $1\frac{1}{2}°$; it is evident that about this time an explosion occurred, the details of which are well recorded on the photograph. The products of the detonation are seen spread out in all directions round the central mass, but the main portion again takes a definite path; not, however, in the original direction of the meteor's flight, as can be readily seen on reference to the photograph.

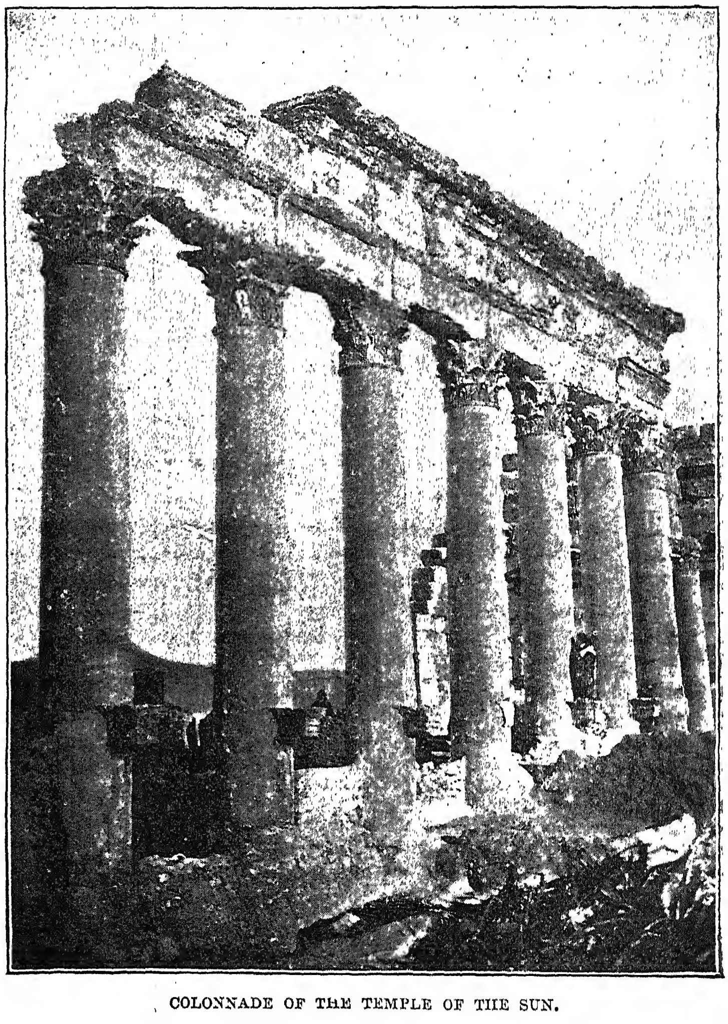
This is probably due to the body being of such a nature as to resist disruption in some directions more than others, and so the resultant of the initial velocity and the new velocity, due to the recoil of the main mass, might lie in some other direction than that of the original path. This has been the case here. If, as an approximation, we take its first appearance to have been at a height of sixty miles, the extreme diameter of the area occupied by the matter expelled during the explosion would be a little more than a mile. The brightest portion of the streak is about $3\frac{1}{2}°$ long, but the fainter trail may be traced for a considerable distance beyond, becoming at last too faint to affect the sensitive plate.

THE ROYAL CITY OF ZENOBIA.[1]

LIKE all ancient cities of the East that have once been centres of trade and culture, but are now only marked by piles of ruins and a few squalid huts, Palmyra has a strange fascination. Though on the edge of the Syrian desert, the site of this ancient city is but five days' journey from Damascus, so that her ruins have been thoroughly explored, her inscriptions copied, and all facts that might be of interest to the man of science, the archæologist, or the historian, have been obtained from her. On opening Dr. William Wright's "Palmyra and Zenobia," therefore, we did not look to find anything very startling or original.

From internal evidence of his work, we gather that Dr. William Wright, who must not be confused with the late Prof. William Wright of Cambridge, is connected with a Protestant missionary society, and from his preface we learn that he was resident in Syria for nine years. It was, perhaps, in consequence of his duties at Damascus that he was unable during this period to break fresh ground in his excursions from that city, and had to be content to follow the more beaten tourist track. His book, in fact, contains an account of two visits to Palmyra, one in 1872, the other in 1874; and as neither of these was of very long duration, we must congratulate him on the production of the present work. The latter part of the book records a trip to the south of Damascus as far as Bosra.

His account of his experiences on the road is amusingly told, and to many will be novel, for Syria is not yet so well known as Switzerland; but what Dr. Wright regards as "adventures," would perhaps appear to the veteran explorer as somewhat ordinary incidents of travel. His description of the ruins, however, and his sketch of the history of Palmyra, though a little superficial and wanting in arrangement, is in the main trustworthy and will, no doubt, prove attractive to many readers. On one occasion the author drops his *rôle* of gossipy narrator, and inserts on p. 124*f.* two Palmyrene inscriptions, to

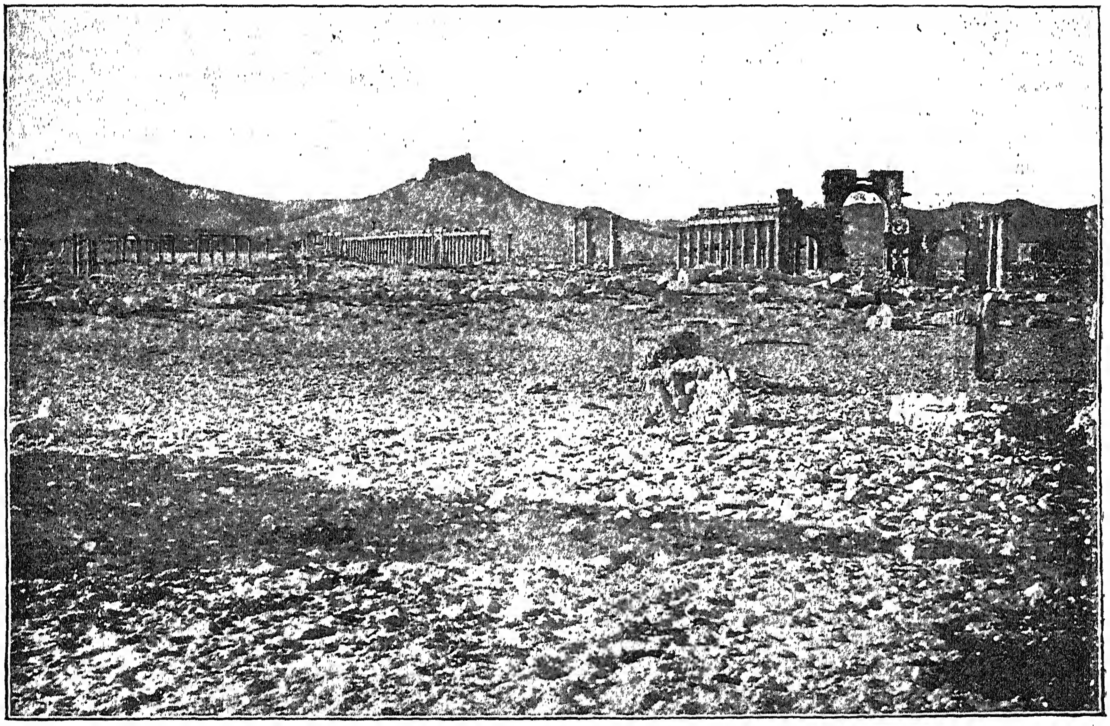


COLONNADE OF THE TEMPLE OF THE SUN.

[1] "An Account of Palmyra and Zenobia, with Travels and Adventures in Bashan and the Desert." By Dr. William Wright. (London: Thomas Nelson and Sons, 1895.)

which he appends translations. The inscriptions appear to have been reproduced from De Vogüé's "Syrie Centrale," pl. 4, Nos. 28 and 29, and the translations are versions of the French rendering to be found on p. 28 *f.* of the same work. We do not blame Dr. Wright for this apparently learned insertion, as no doubt many of his readers would be interested in seeing what a Palmyrene inscription looks like; but we do think he should have given some reference or indication of the source from which he took his information. It is the more to be regretted that he omitted to do this, as in his translation Dr. Wright has written "the daughter of *Zabbai*" for *Bath-Zebhīnah* of the original, not recognising the proper name, Ζηνοβία, in its semitic dress—an odd mistake to come across in a book which claims to give an account of that great queen.

In a book of travel one does not expect any remarkable purity of style, but Dr. Wright has perhaps too great a liking for fine language; as, for instance, when he describes a lady out riding as "bounding over the desert on a splendid charger, whose neck of thunder swayed hither and thither to her silken touch." But this is a minor detail, and, although we cannot honestly say that the man of science or antiquary will gather any particularly new or useful information from his pages, it would be ungenerous to discourage any one from describing, for the benefit of other people, the places and incidents from which he himself has derived pleasure. The book, in fact, would form a chatty and by no means uninteresting companion to any more solid work on the same subject, such as Socin's "Palestine and Syria," published by Baedeker, in which all historical and topographical facts concerning Palmyra and Syria in general are carefully arranged. We may add that the volume before us is prettily bound, well printed, and has plenty of illustrations, two of which are here reproduced. The one gives a view of a colonnade from the Temple of the Sun at Palmyra, while from the other some idea can be obtained of the forest of columns which are still standing on the site of that once famous city.



TRIUMPHAL ARCH, WITH CASTLE IN THE DISTANCE.

NOTES.

THE Council of the Pasteur Institute are about to organise a committee to make an international appeal for funds to erect a statue of Pasteur in Paris.

AN expedition to observe the solar eclipse next August will be sent out to Yezo from Amherst College, U.S.A., under the direction of Prof. David P. Todd. The expedition is expected to leave San Francisco next spring.

IT is reported by Reuter that steps are being taken to invite the Prince of Wales and the Secretary of State for the Colonies to visit Toronto in August 1897, when the British Association meets there, to open the new municipal buildings, which by that time will have been completed at a cost of £500,000.

AN Electrical Lighting and Power Act has recently been passed at the Cape of Good Hope, authorising regulations for the safety of the public. Mr. A. P. Trotter has been appointed Government Electrician and Inspector under this Act.

THE deaths are announced of Dr. A. J. Woïtow, Professor of Bacteriology at Moscow; Dr. Ludwig Rütimeyer, Professor of Zoology at Basel; Dr. F. P. Porcher, of Charleston, South Carolina, author of numerous works on pharmaceutical botany.

THE Executive Committee of the City and Guilds of London Institute are inviting applications for the appointment to the Salters' Company's Research Fellowship for the ensuing year. The Fellowship was founded by the Salters' Company for the encouragement of higher research in chemistry in its relation to

manufactures, and particulars of the scheme under which the award is made may be had on application to the Honorary Secretary, at the head office of the Institute, Gresham College, Basinghall Street, E.C. The results of the researches by Dr. Martin O. Forster, the Salters' Research Fellow for the current year, at the Institute's Central Technical College, were communicated to the Chemical Society at its last meeting.

A NUMBER of the former students of Prof. Bonney's Geological Classes at the University of Cambridge, and at University College, London, have united to present him with his portrait as a memento of their personal esteem, and in recognition of his labours among them, and of his services to geological science. The portrait will be presented to Prof. Bonney on Monday, December 16, at 3.30 p.m., at University College, Gower Street. The work has been executed by Mr. Trevor Haddon, of the Abbey Studio, 18 Great George Street, Westminster, where it will be on view on Friday and Saturday, December 13 and 14, from 10 to 4. A platinotype reproduction of the picture has been prepared under the supervision of the artist, who will be glad to afford further information.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Prof. J. G. McKendrick, six lectures (adapted to a juvenile auditory), on sound, hearing and speech; Prof. Charles Stewart, eleven lectures on the external covering of plants and animals: its structure and functions; Prof. H. Marshall Ward, three lectures on some aspects of modern botany; Lord Rayleigh, six lectures on light. The Friday evening meetings will begin on January 17, when a discourse will be given by Lord Rayleigh, on more about argon; succeeding discourses will probably be given by Prof. Burdon Sanderson, Mr. W. S. Lilly, Dr. John Murray, Mr. J. J. Armistead, Dr. Edward Frankland, Mr. A. R. Binnie, Mr. Sidney Lee, Prof. T. R. Fraser, Prof. Dewar, and others.

THE Government of India has resolved to establish an imperial bacteriological laboratory at Agra, under the directorship of Prof. Hankin, and an imperial chemical laboratory in Calcutta. According to the *British Medical Journal*, health officers are to have a six months' training in bacteriology; special diplomas, after careful training in hygiene, are to be granted by the colleges, and 1900 municipalities will be expected to appoint trained men for sanitary work. To make the scheme complete, further laboratories will probably be organised on a smaller scale in each of the great Indian presidencies, and arrangements will be made for giving six months' training of medical officers in the service. The scheme, when completed in details and in course of time, will give to India a perfect sanitary organisation and service.

THE fireball of November 22, which formed the subject of letters in NATURE of November 28 and December 5, attracted the attention of a large number of observers. Mr. W. B. Tripp, writing from Isleworth, says the meteor was observed there at about 6.50 p.m. Mr. J. H. A. Jenner noted the spectacle at Lewes at the same time, and remarked that the trail was visible for two or three minutes, and remained quite straight until it disappeared. He adds; "The path of the meteor was along the eastern sky from south to north, following a line from about the centre of the constellation Perseus towards α Ursa Major. The colour of the ball itself was reddish, and the motion seems to have been comparatively slow." This meteor was seen also at Chichester and Dover. At the latter place, the time noted by Mr. W. H. Pendlebury was 6.53 p.m., and the light emitted was said to have been "sufficiently brilliant to throw the electric light into shadow, while the glow remained visible for between one to two seconds."

FROM a letter addressed to Mr. R. H. Scott, by Dr. J. Hann, we are glad to learn that the Austrian expedition for the Society's exploration of the Red Sea has succeeded in establishing meteorological stations at Jedda, Kosseir, and Brothers Islands, about forty miles off the coast of Upper Egypt, and has provided them with self-recording barometers. At the latter station the observer is a Norwegian, in charge of the lighthouse. It is hoped that the observations will be continued for at least two years, and will furnish an important contribution to the meteorology of the district. Observations have been made at the Dutch Consulate at Jedda for some years, and by the Italians at Massowa, but, generally speaking, observations at land stations in those parts are scarce. The expedition will investigate the southern parts of the Red Sea, between Jedda and Massowa, during the winter months, and we learn that the zoological collections have up to the present time been very satisfactory.

ZOOLOGISTS will be glad to note that the editor and publisher of the *Zoologischer Anzeiger* have recently announced the steps which they are prepared to take in conjunction with Dr. Haviland Field towards a reform of existing bibliographical methods. With the new year the *Zoologischer Anzeiger* will be to some extent remodelled. It will retain its present mode of publication in approximately fortnightly numbers, as well as its division into two sections, independently paged, one dealing with scientific communications, and the other with current literature. But complete volumes of the *Anzeiger* will no longer take the form of annuals. They will be determined simply by bulk: forty sheets of "Wissenschaftliche Mittheilungen" and forty sheets of "Litteratur" will together compose a volume. The "Litteratur" section, moreover, will be obtainable in three different forms: (1) the ordinary edition, (2) an edition printed on one side of the paper only, and (3) a ticket-edition, suitable for the formation of card-catalogues. The two first editions of this "Bibliographia Zoologica" will be issued from the office of the *Zoologischer Anzeiger* in Leipzig, but the ticket-edition will be exclusively issued from the office of Dr. Field's International Bibliographical Bureau in Zürich. This combination of Dr. Field's and Prof. Carus's forces should prove of great service to students of every branch of zoological literature, which in these latter days has attained such enormous dimensions.

IT is now nearly twenty years since the brilliant, if brief, career of *Bathybius* was extinguished by the discovery that this primordial organism was in fact no organism, but a colloid precipitate of calcium sulphate produced by the action of alcohol on sea-water. Ten years later, however, *Bathybius*, or its next of kin, seemed to come to life again in the form of a remarkable protozoon parasite discovered by M. Moniez in the body cavity of certain small fresh-water Crustaceans (Ostracoda and Cladocera), and named by its discoverer *Schizogenes parasiticus*. This creature was described as an irregularly shaped disc of homogeneous, slightly refractile protoplasm, which showed no differentiation into zones and contained no nucleus, no contractile vacuole, and no granule of any kind. It was stated to exhibit a certain power of movement, and to reproduce itself by fission or constriction. It would appear, however, that *Schizogenes* is not to escape the fate of its more illustrious predecessor. Dr. G. W. Müller, well known by his monograph on Ostracoda in the Naples series, has found that the *Schizogenes* of the Ostracoda is no organism, but the viscid chitinous secretion of the so-called shell-gland. (*Zool. Anz.*, No. 486.) The secretion shows the different shapes and movements characteristic of *Schizogenes* owing to the absorption of water. *Schizogenes* can, in fact, be created at will by compressing the fresh shell-gland of an Ostracode in water beneath a cover-slip.

IT has been shown by several investigators that luminous vibrations of short wave-length are capable of producing an inflammation of the skin. It is, therefore, easy to understand

that such actinic rays increase an inflammation already existing, as is the case in small-pox. The latest contribution to the knowledge of this action appears in the *British Medical Journal*, in which Dr. N. R. Finsen, of Copenhagen, gives the results obtained by keeping small-pox patients in non-actinic light. The following are the main points concerning the treatment:—(1) The exclusion of the chemical rays must be absolute; even a brief exposure to daylight may produce suppuration and its sequelæ. In other words, the skin during small-pox is as susceptible to daylight as a photographic plate, and must be kept from the chemical rays in the same way and almost as carefully. If, therefore, red window glass is employed, it is necessary for it to be of a deep red colour, and if curtains are used, they must be very thick or in several layers. When the patient takes his meals, or during the physician's rounds, artificial light—for instance, faint candle-light—may be used without any danger. (2) This method does not prevent but allows the employment of any other treatment which may be considered necessary. (3) The treatment should be commenced as early as possible; the nearer the commencement of the suppuration the smaller the chance of success. (4) The patient must remain in the red light until the vesicles have dried up.

ONE of the difficulties which attends the production of the new serum remedy for diphtheria is the uncertainty which accompanies the elaboration of toxic products by the diphtheria bacilli in culture media. This diphtheria-toxine, as it is called, has to be produced on a large scale, and it must be of a requisite degree of virulence, or it will not, when subsequently inoculated into horses, endow the blood-serum of the latter with the necessary degree of diphtheria-immunising properties. Even the bacilli taken direct from the throat of a diphtheria patient are not capable of elaborating, in culture media, toxines of a sufficient strength for the purposes of anti-diphtheritic serum production, and recourse has to be had to increasing their virulence by first inoculating them into guinea-pigs, and then transferring them to the culture media. The reason of this most inconvenient idiosyncrasy, so characteristic of diphtheria bacilli, has until recently not been surmised, but Prof. Spronck of Utrecht has unravelled the mystery in a most interesting manner.

THE last number of the *Archives des Sciences Biologiques*, published by the Imperial Institute of Preventive Medicine in St. Petersburg, gives the annual report on the anti-rabic inoculations carried out during the past year in St. Petersburg and Odessa respectively. In St. Petersburg, 224 persons were treated by Pasteur's method, and only three succumbed to hydrophobia. In two of these cases death ensued during the treatment and before, therefore, the inoculations had produced their full effect; in the other case, the patient was not treated until thirteen days after he had been bitten, and he died just three weeks after the inoculations had been completed. Amongst the rabid animals, 193 were dogs, 18 wolves, 7 cats, 5 horses, and 1 pig. At Odessa, no less than 984 persons were inoculated anti-rabically, the larger number of persons so treated being between twenty-one and forty years of age. The death-rate from hydrophobia, including those persons who died before the treatment was completed, was equal to 0·32 per cent. An instance is recorded of a death from hydrophobia having taken place one year after the anti-rabic inoculations were completed. The patient was severely bitten on his hands by a mad dog, and presented himself a week later at the Institute, although the wounds had been cauterised three hours after their infliction; the inoculations were completed on July 14, 1893, and on July 15, 1894, he died of hydrophobia. At Odessa the largest number of cases were admitted in the months of May, June, and July; but at St. Petersburg, contrary to the usual experience, the maximum number of patients were received in the spring and autumn respectively.

A NUMBER of interesting observations of the habits of the common bat and the long-eared bats in captivity are recorded by Mr. John D. Batten in *Nature Notes* for December. Common bats appear to be practically blind, yet Mr. Batten mentions that he never knew a bat fly against a window or against any obstacle: light or darkness apparently making no differences in its flight. Long-eared bats appear to see better than common bats, and their hearing is much more acute. There is seldom any difficulty in inducing bats to feed. Mr. Batten fed his bats at first on flies, moths and grasshoppers, but when these became scarce, he fed them almost entirely upon meal-worms. It is remarkable that bats, on being captured, readily adopt an entirely new method of life, and the new habits thus acquired quickly become natural. When bats are asleep in October and November, they take sometimes as long as a quarter of an hour to awaken. Mr. Batten has observed the process carefully, and finds it to be always the same. He thus describes it: "The bat when thoroughly asleep is cold, dead cold to the touch. If I then took it in my hand it would not attempt to move about or seek for food, but lie quite still. On putting it to my ear I could hear a throbbing begin, at first very slowly and not very regularly, more than a second between the beats. Gradually the throbbing became quicker and quicker until it was impossible to count the beats, at the same time the warmth of the body was increasing very rapidly, and the bat quivering visibly. At last the throbbing becomes a continuous whirr, not unlike the purring of a cat, and the body feels quite hot to the hand. Then, rather suddenly, the throbbing quiets down like water coming to the boil, it slows somewhat, and becomes almost inaudible. The bat coughs or sneezes, chatters a little with its teeth, and begins to move about expecting to be fed." Of three bats set to hibernate at the end of November in 1890, two were found dead at the end of the following January, and one was alive and perfectly strong; its fur was in good condition, and it fed well, and the hibernation had not affected its power of flight.

THE occurrence of perlitic cracks in a rock of stony texture has always been held as evidence of its alteration from an originally glassy state; but within the last two years doubt has been cast on this conclusion through Mr. W. W. Watts's observations on the pitchstone of Sandy Braes, in which perlitic cracks were claimed as traversing the quartz and other crystals as well as the matrix. In a paper read before the Royal Society of New South Wales, Mr. W. F. Smeeth has, in connection with a description of a local pitchstone resembling that of Sandy Braes, discussed fully the exact mode of origin of perlitic cracks and the features which distinguished them from other curved cracks. He points out that the artificial perlitic structure that can be made in a Canada balsam film is a "two-dimensional phase of the natural structure," and from its characters he tries to deduce those of the tri-dimensional phase. His conclusion is that natural perlites are "cracks of more or less irregularly spiralloid character, occurring in the interspaces between sets of polygonal cracks." Allowing for irregularities due to want of homogeneity in the lava, and for the fact that, whereas in the artificial structure the axes of the spirals are all normal to the surface of the film, the axes of the natural spiralloids are variable in direction, he deduces a series of possible figures for sections of true (tri-dimensional) perlitic structure. The most obvious of the characteristics shown by these theoretical sections is that the curves never meet otherwise than tangentially. That these theoretical figures are actually those seen in sections of typical perlitic rocks, affords strong evidence of the correctness of the views suggested as to their mode of formation. Passing on to consider the curved cracks in the quartz-crystals (shown by the New South Wales specimen as well as by that described by Mr. Watts), he points out that the cracks, instead of meeting one

another tangentially, do so at marked angles, and are therefore not truly perlitic; while he shows how these also can be imitated artificially. Reasons are given for doubting the perlitic character of cracks in lithoidal rocks claimed as such, and finally the author considers it "extremely improbable that a crystalline aggregate, consisting of individuals with various cleavages and different coefficients of contraction, would be able to develop so delicate a structure" as the true perlitic.

THE *Naturwissenschaftliche Wochenschrift* of November 17 contains a summary of some of the most important preliminary results of forty-seven balloon ascents made in Germany between June 1888 and February 1895, compiled from communications by Dr. R. Assmann in various scientific journals. In four of the ascents the balloons contained self-recording apparatus only, and of the other forty-three cases, M. Berson, an assistant in the Meteorological Office at Berlin, made thirty-six ascents (in four of which he was quite alone), and Lieut. Gross made twenty-eight ascents. The heights attained in some of the voyages were the greatest yet recorded. It was found: (1) That the air-temperature above 4000 metres was considerably lower than had been theoretically assumed, or deduced from earlier ascents. This apparently points to the fact that in the earlier ascents the thermometers were affected by solar radiation, while in the recent ascents this defect was obviated by the use of the aspirator invented by Dr. Assmann. (2) That the assumption that the decrease of temperature with height was most rapid in the lower strata of air, is untenable; the decrease was found to be fairly uniform with increasing altitude, and the isotherm of 32° F. was found to lie between 3600 and 3800 metres. (3) That the stratum between 2000 and 4000 metres was relatively too warm, owing to the greater condensation of clouds in those regions. (4) That the seasonal variation of temperature was very small above the height of 6000 metres. (5) That the inversion of temperature during winter, and at night time, up to the height of 1000 metres, appeared to be a regular phenomenon. (6) That cumulus clouds were at times found at unexpected altitudes. (7) That the surface of a massive layer of cloud affected higher strata of air thermically and electrically, like the surface of the earth. (8) That the electrical potential decreased with height, pointing to the earth as the sole source of atmospheric electricity. (9) That the aqueous vapour was unexpectedly small in even moderately high regions of the air, the variation in amount between two layers of cloud being often very great. The balloon ascents have been temporarily discontinued, with a view to discussing the existing materials.

THE Cryptogamic journal *Grevillea*, which has been published at irregular intervals since Dr. M. C. Cooke resigned the editorship, will not appear again. The papers which were intended for it have been transferred to the *Journal of Botany*, still under the editorship of Mr. James Britten. This journal will be published monthly as heretofore, but will be increased in size from thirty-two to forty-eight pages.

THE Report of the Department of Botany at the British Museum for 1894, by Mr. W. Carruthers, shows that many interesting additions were made to the Herbarium during the year, one of the most important being the collection of freshwater Algæ made by the late Dr. A. H. Hassall, which includes a number of type specimens. Collections of flowering and flowerless plants have also been obtained, by donation, exchange, or purchase, from all parts of the world, especially from British India and from our other colonies.

MR. F. N. WILLIAMS has issued a provisional and tentative list of the orders and families of British flowering plants, founded on the system of classification of certain continental botanists. He proposes to divide Phanerogamia into three "phyla," Angiospermæ, Anthospermæ, and Gymnospermæ, the second of these consisting of one family only, the Loranthaceæ. The Angiospermæ are again divided into two classes, the Dicotyledones and Monocotyledones; the Dicotyledones consist of two subclasses, the Sympetalæ (Tetracyclicæ and Isocyclicæ) and the Choripetalæ (Eucyclicæ, Phalangiata, Aphanocyclicæ, Calyciflora, Centrospermæ, and Archichlamydeæ). The whole range of flowering plants is further grouped under 42 orders and 110 families.

APPENDIX II. of the *Bulletin of Miscellaneous Information* of the Royal Gardens, Kew, is devoted to a list of the New Garden Plants of the year 1894. It includes not only plants brought into cultivation for the first time during the year, but also the most noteworthy of those which have been reintroduced after having been lost from cultivation, and some which had not previously been properly described. In addition to species and botanical varieties, all hybrids, whether introduced or of garden origin, but described for the first time in 1894, are included. The number of hybrids is especially noteworthy in *Cypripedium* and other genera of *Orchideæ*. The total number of names in the list is about 500.

AN absolutely black body is one which both radiates and completely absorbs radiations of any wave-length. It is practically impossible to prepare such a body by artificial blackening; but Messrs. W. Wien and O. Lummer have invented a body which answers all requirements in the way of perfect blackness. This quality is impaired by reflection of any kind from the surface, and hence the inventors take care that the body in question shall be supplied with exactly those kinds of radiation which it reflects, and which its radiation lacks in consequence. The interior of a hollow sphere at any uniform temperature is in a perfect condition in this respect, since there is perfect equilibrium between the heat received and given out. By making an opening at one point, this state is only slightly disturbed, and the inside of the hollow sphere will act as a perfectly black body. From a disquisition which appears in *Wiedemann's Annalen*, it appears that the authors propose to use this body and a bolometer to test Boltzmann's law, which makes the radiation proportional to the fourth power of the absolute temperature.

Industries and Iron has commenced the issue of a series of portraits of eminent workers in the field of engineering science. Two portraits have already appeared as supplements to our contemporary—one of Lord Armstrong, in the issue of November 29, and the second, of Sir Douglas Fox, in the issue of December 6.

THE December number of *Science Progress* contains an account, by Dr. D. H. Scott, F.R.S., of the late Prof. Williamson's researches on the carboniferous flora. Other papers included in the number are on mineral transformations, by Mr. H. A. Miers; some applications of the theory of osmotic pressures to physiological problems, by Dr. E. Starling; theories of electrolysis, by Mr. C. Dampier Whetham; recent papers treating of the Upper Palæozoic beds, by Mr. Marr; and a notice of the discoveries and researches of the great physiologist, Carl Ludwig, by Dr. Leon Asher.

SOME of our readers may be interested in an ingenious puzzle which has been devised by Mr. W. Radcliffe. It consists of three sets of discs of equal sizes, each set containing the seven principal colours of the spectrum; and the problem is to arrange nineteen of these so that there will be seven groups of the same size and shape, each group containing the seven different colours. Notwithstanding that there are 5040 possible solutions to this "seven-colour puzzle," the result is by no means easily attained. It should furnish a useful exercise for young children in distinguishing colours.

THE American Ornithologists' Union held its thirteenth annual congress in Washington at the middle of last month. We understand from the New York *Nation*, that a new feature was a special memorial session, at which the late Mr. G. N. Lawrence was eulogised by Mr. D. G. Elliot, and the late Prof. Huxley by Dr. Elliott Coues. The regular scientific sessions were opened by an exhibition of unpublished water-colour paintings by Mr. Louis Agassiz Fuertes, a student of Cornell University, on whom some of the members seemed to think that the mantle of Audubon himself had fallen. Mr. W. T. Blanford was promoted from corresponding to honorary membership, and Mr. W. H. Hudson was admitted to the former. Mr. William Brewster, of Cambridge, succeeded Dr. Coues in the presidency, and the Union meets at Cambridge, Mass., next year.

THE recently-published number of the *Proceedings* of the Liverpool Geological Society (vol. vii. part 3) contains the address on "Chemistry as an Aid to Geology," by Mr. Dickson, the retiring President. He points out, among other things, the value of chemical analyses in tracing the source of drift-deposits, and particularly insists on the importance of discriminating between true *clay* and the *rock-flour* which commonly passes by the same name. Other papers in the same number deal with matters of local geology, including descriptions of new railway cuttings near Seacombe, and a moraine in the Brecknock Beacons. An important discovery of abundant *Lepidostrobi*, exhibiting various stages of development, and in actual connection with the branches of *Lepidodendron*, is recorded from St. Helens by Mr. Lomas, who also contributes an account of the Faroë Islands.

MESSRS. C. W. FAULKNER AND CO. have sent us a number of specimens of their Christmas publications, including Christmas cards, photogravure pictures, calendars, and games. What connection there is between these things and science may not be very clear at first sight. We are so used to calendars that we forget that time was when men had to look to the skies "for signs, and for seasons, and for days and years." This duty is now relegated to astronomical observers and computors, while the average man concerns himself with more mundane affairs. The pictures upon the Christmas cards are not gaudy abominations, but attractive reproductions from photographs of bits of scenery; they should remind people of the gifts of science to art, and, with the photogravure pictures, they show what excellent illustrations can now be obtained by photographic processes. As to the new games received in Messrs. Faulkner's packet, they are ingenious and offer means of pleasant relaxation from mental work.

THE first number of the *Scientific African*, which has come to hand, gives promise of a useful existence, as an exponent of South African science, arts, and crafts. The journal has a large region, full of objects and wonders of transcendent interest, as its sphere of influence. It can do much to stimulate scientific observation, and in its pages one may hope to find valuable information on the animals, minerals, and industries of South Africa. We notice in the number before us an article in support of the geological survey of Cape Colony, showing that the immediate undertaking of the survey is necessary: (*a*) in the interests of pure science, (*b*) in treating the land, (*c*) for the sake of the water supply, (*d*) for the development of the mineral resources. There is also an article on the white-tailed wildebeest or gnu, accompanied by a photograph of a male and female contained in the Selous collection in the South African Museum. Among other contributions are articles on natural gas and petroleum, a biographical notice (with portrait) of Dr. P. D. Hahn, an account of the Brandolei hot spring near the city of Worcester, South Africa; several letters, science notes, a notice of Pasteur, and a brief report of the British Association meeting at Ipswich. We wish the new journal a long and successful life.

THE forty-fifth volume of the *Jahrbuch der k.k. Geologischen Reichsanstalt* opens with a valuable series of analyses made in the laboratory of that institution by C. von John and C. F. Eichleiter. The first group of analyses are of coals of various ages and from various localities in Austria. The rest comprise ores, sedimentary rocks, water, metals, &c. This is followed by a paper on the distribution of the minerals in the lodes of Strebsko near Pribram. Kerner contributes a description of some Cretaceous plants from Lesina, which are of interest owing to the abundance of Cycadeæ. Felix Karrer issues two further instalments of his studies on the Cainozoic deposits of the Vienna basin. Dr. F. E. Suess gives the results of his investigations as to the earthquake which occurred around Neulengbach, near Krems on the Danube, on January 28, 1895. He discusses previous shocks in the same district, and concludes that the transverse axis of this earthquake area follows the strike of the mountains. C. Zahalka discusses the stratigraphical position of the "Bischitzer Uebergangsschichten," which Anton Fric regarded as the lowest member of his Iserschichten group. Zahalka divides the Bohemian chalk into ten zones, and on Fric's view the Bischitzer passage beds would belong to zone No. 8 of this series. The author, however, maintains that it belongs to his zone No. 4, or the Upper Drinowèr Knollen of Fric; that is to say, in English terminology it is transferred from the Senonian to the Lower Turonian. A second important paper on the Bohemian Chalk is contributed by J. J. Jahn, who advances the important conclusion that the Iser Schichten of Eastern Bohemia, are only a local representative of the Teplitzer Schichten, instead of being a distinct formation and of an earlier age.

Bulletin vol. ii., No. 4, of the College of Agriculture, Imperial University, Tokio, Japan, contains much gratifying evidence of scientific activity in the Far East. Dr. Oscar Loew, the professor of agricultural chemistry, continues his paper on "The Energy of the Living Protoplasm," and Mr. G. Daikubara has a second paper on "The Reserve Protein in Plants." Then follow four papers by Mr. Y. Kinoshita, dealing severally with the consumption of asparagine in the nutrition of plants, the assimilation of nitrogen from nitrates and ammonium salts by phænogams, the presence of asparagine in the root of *Nelumbo nucifera*, and the occurrence of two kinds of mannan in the root of *Conophallus konyaku*. Mr. K. Yoshimura has a note on the chemical composition of some mucilages, and makes incidental reference to the facts, of industrial importance, that the mucilage of *Sterculia platanifolia* and of *Kadzura japonica* is used in Japan for sizing paper, and that the tuberous rootstock of *Colocasia antiquorum* serves as a valuable food in Japan, where it is largely cultivated. Mr. M. Inouye deals with the preparation and chemical composition of *tofu*, which consists principally of the protein-matter of the soya bean, is said to be as easily digestible as beef, and can therefore be used to make up the deficiency of proteids in rice, the staple food of man in Japan and China. The same author has a note on *nukamiso*, which is rice-bran in a state of lactic fermentation, and is used to soften certain vegetable foods, such as the radish and the fruit of the egg-plant, which are rendered palatable and easily digestible when left in a large quantity of *nukamiso* for about twenty-four hours. Mr. J. Cho answers in the negative the question, Does hydrogen peroxide occur in plants? Mr. Yoshimura, previously mentioned, has a note on the behaviour of hippuric acid; he concludes that decomposition of hippurates proceeds more quickly in the surface soil than in the subsoil, that it is attended with liberation of ammonia, and that it is chiefly dependent upon the action of micrococci.

THE additions to the Zoological Society's Gardens during the past week include an Arabian Baboon (*Cynocephalus hamadryas*) from Egypt, presented by Mrs. Locke King; two Tufted Umbres (*Scopus umbretta*) from Bechuanaland, South Africa, presented by Mr. F. J. Newton, C.M.G.; four Cockateels (*Calopsitta novæ-hollandiæ*), a Many-coloured Parrakeet (*Psephotus multicolor*), a Rose-Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mr. Thomas J. Manns; two Red and Blue Macaws (*Ara macao*), five Saffron Finches (*Sycalis flaveola*), two Pileated Song Sparrows (*Zonotrichia pileata*), a Guttural Finch (*Spermophila gutturalis*), a Plumbeous Finch (*Spermophila plumbea*), a White-throated Finch (*Spermophila albogularis*), a —— Finch (*Spermophila torqueola*), a Black-throated Siskin (*Chrysomitris magellanica*) from South America, a Brambling (*Fringilla montifringilla*), a Greenfinch (*Ligurinus chloris*), European, presented by Mr. A. J. Chalmers; a Red-vented Bulbul (*Pycnonotus hæmorrhous*) from India, presented by the Hon. Miss E. Dillon; a Chestnut-breasted Finch (*Donacola castanothorax*) from Queensland, presented by Mr. A. Rowney; a Hardwick's Mastigure (*Uromastix hardwicki*) rom India, presented by Mr. W. Allen; a Black Swan (*Cygnus atratus*) from Australia, deposited; two Black-necked Stilt Plovers (*Himantopus nigricollis*) from South America, a Green-headed Tanager (*Calliste tricolor*) from South-east Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

THE NEW COMETS.—Numerous observations of Perrine's Comet and a few of Comet Brooks are reported in *Ast. Nach.*, No. 3320. The former is generally described as bright, the nucleus being about 7th magnitude, while the tail is pretty broad, and variously estimated at from 10′ to 20′ in length. From observations up to November 25, Dr. E. Lamp finds the date of perihelion passage to be 1895, Dec. 18·3509 Berlin mean time, and the following ephemeris is given:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
Dec. 11	15 59 40	−24 7·6	28·30
12	16 16 14	26 2·1	
13	34 33	27 50·5	
14	16 54 40	29 25·0	
15	17 16 5	−30 37·4	60·0

The unit of brightness is that on November 18. The comet is brightening with great rapidity, but it is so near the sun that observations can only be made in daylight.

Comet Brooks apparently presents only the appearance of a feeble, diffused nebulosity without condensation. The following ephemeris for Berlin midnight is due to Dr. H. Kreutz:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
Dec. 12	7 16 42	+57 23·5	0·8
13	7 0 37	59 45·8	
14	6 43 39	61 48·0	0·6
15	26 4	63 31·2	
16	6 8 2	64 56·7	0·5
17	5 49 52	66 6·2	
18	31 47	67 1·4	0·4
19	5 14 6	67 43·7	
20	4 57 4	+68 15·0	0·3

The brightness on November 24 is taken as unity. According to the elements adopted, perihelion was passed on October 20·887.

It will be seen that the comet is now circumpolar.

THE GREAT COMET OF 1843.—In the *Astronomische Nachrichten*, No. 3320, Dr. Kreutz gives another chapter in the history of the three interesting comets of 1843 I., 1880 I., and 1882 II., all belonging to one cometary system, distinguished by great brilliancy and small perihelion distance. In 1889, Dr. Kreutz published an exhaustive monograph on the motion of the 1882 comet, that one of the system which, it will be remembered, was first seen in this country by Dr. Common, in bright daylight, and which at the Cape was followed till it seemed to touch the sun's limb. The present inquiry has reference to the 1843 comet, also seen and observed in full daylight, and the motion of which had been made the subject of a classical discussion by Dr. Hubbard (*Astronomical Journal*, vols. i. and ii.). The improved normal places which Dr. Kreutz has formed are not, however, very well represented by Hubbard's orbit, and new elements have been derived, which, of course, do not differ materially from the earlier results. The period, deduced as the most probable, is 512 years, or twenty years less than Hubbard's period; but the interesting point in the present discussion is the determination of several orbits with various values for the semi-axis major, assigned on the hypothesis that this comet of 1843 is identical with some other the appearance of which has been recorded. The periods assigned are thirty-six years, suggested by a possible identity between the 1843 and 1880 comets; 175 years, which would make the 1843 comet a reappearance of that in 1668; 800 years, a period approximately equal to that found for 1882 II., and finally a parabolic orbit. The result is to settle very decisively that there is no identity between the 1843 and 1880 comets, and almost as certainly that the comet is not a return of that of 1668. On the other hand, it is by no means certain that equal periods would not satisfy the observations in both 1843 and 1882, but true parabolic motion cannot be accepted. From the position of the line of intersection of the orbital planes of the two comets 1843 and 1882, Dr. Kreutz infers that they originally formed one comet, and that the separation into two distinct bodies was effected near the time of perihelion passage. Seeing that the 1843 comet would approach within 100,000 miles of the sun's surface, it is easy to suggest a cause for the subdivision.

NEBULOSITIES AROUND THE PLEIADES.—The nebulous relationships of the Pleiades, brought so forcibly into view by the beautiful photographs of Dr. Isaac Roberts, are carried a stage further by a photograph which we owe to Prof. Barnard. This was taken with the 6-inch portrait lens with a total exposure of 10h. 15m. on December 6 and 8, 1893, and an enlargement and description of the plate are given in the current number of *Knowledge*. In this photograph the nebulæ photographed by Dr. Roberts are submerged in the "burnt out" images of the brighter stars; outside the group various nebulous masses and streams are seen extending in all directions, but apparently connected with the nebulosities of the cluster itself. The most prominent of the new nebulosities are two irregular streams flowing from the north and south sides of the cluster, and running three or four degrees easterly; the northern stream is double for a part of its length, but the upper part is very feeble. The nebulosities have also been photographed by Dr. Wilson, of the Goodsell Observatory, with an exposure of 11 hours; they are best seen by increasing the contrast in a positive copy of the plate.

THE FIRST STEPS IN SERUM-THERAPY.

IN scientific discovery, as in many other walks of life, it frequently happens that the magnitude of the result achieved casts into obscurity the labours which led up to that discovery, just as the parent is often forgotten in the fame which may subsequently surround the work of his offspring. It is rarely, however, that so young an infant as we must perforce recognise antitoxic serum to be, succeeds in baffling the pedigree-hunter; barely recognised three or fours years back, its parentage has, however, already become the subject of much discussion.

Dr. Welch, of Baltimore, in an exhaustive paper[1] on the treatment of diphtheria by anti-toxin, commences with an historical survey of the subject, and states that Babès and Lepp in 1889 were the first to publish results of experiments to solve the question whether the fluids and cells of animals which have been rendered immune by vaccination, have not become vaccines and capable of protecting also other organisms. On turning, however, to the volume of the *Annales de l'Institut Pasteur*, in which the memoir by Babès and Lepp[2] on this subject is published, we find that they do not claim to have originated these investigations, for they expressly state: "We have seen, in the course of our investigations, that this problem has been studied experimentally in various diseases, and this fact encouraged us to pursue this idea."

[1] "The Treatment of Diphtheria by Antitoxin," *Trans.* Association of American Physicians, vol. x., 1895.

[2] "Recherches sur la vaccination antirabique," *Annales de l'Institut Pasteur*, vol. iii., 1889.

In the address on Pasteur, delivered before the British Association at Ipswich, Prof. Percy Frankland distinctly attributes this discovery to Héricourt and Richet. He said: "This astounding antitoxic property of the blood-serum of an artificially immunised animal was first discovered by Héricourt and Richet in respect of animals immunised against one of the common abscess-producing organisms."[1]

Now Dr. Welch goes out of his way in a foot-note reference to Babès and Lepp to mention that "Richet and Héricourt are sometimes quoted as the first experimenters to show that the blood of animals is capable of conferring protection upon susceptible animals, but their work *has no reference to modern serum-therapy, as their experiments were made with the blood of dogs which had not previously been vaccinated or treated in any way.*"

If we refer to the *Comptes rendus* for 1888, we shall find a paper by Héricourt and Richet entitled "Sur un microbe pyogène et septique (*Staphylococcus pyosepticus*) et sur la vaccination contre ses effets." In this memoir the authors describe their experiments on procuring immunity in rabbits towards this organism by inoculating them with weakened cultures of it. They conclude by saying: "The methods which we have used to procure these vaccinations are those in general use by Pasteur and his pupils. But we have conceived of a new method (the peritoneal transfusion of a dog's blood into rabbits), a process which also produces vaccination; in a subsequent communication we shall describe in detail the results obtained by this method."

It is this subsequent paper which has been entirely overlooked by Welch and other investigators. Strange to say, also, there is absolutely no reference to it in the *Centralblatt für Bakteriologie*, although a very incomplete abstract of the earlier paper did appear in this journal. This second communication, to which, in the light of recent scientific investigations on the use of antitoxic serum, much interest and importance attaches, is entitled "De la transfusion péritonéale, et de l'immunité qu'elle confère" (*Comptes rendus*, 1888, p. 748).

The following passage, taken from this memoir, will perhaps most clearly convey some idea of what results were obtained by Héricourt and Richet in these first investigations in serum-therapy:—"On October 4, seven rabbits were inoculated with four drops of a culture of the *Staphylococcus pyosepticus*, six having received 48 hours previously some dog's blood in the peritoneum. The control animal[2] died in less than 20 hours after the inoculation. Of the six others, three died, one 50 hours, the other 70 hours, and the third 90 hours after the inoculation. The three others survived; they are still alive at the present time. To explain the apparent inconsistency of these results, it must be noted that the transfused blood was obtained from two different sources: first, from a dog which had never been experimented upon—the rabbits which received this blood did not survive the inoculation; secondly, from a dog which had survived inoculation made some months previously with the *Staphylococcus pyosepticus:* the three rabbits which received this blood survived the subsequent inoculation with the *Staphylococcus pyosepticus.*" These results were confirmed by further investigations, proving, as the authors say, that it was not "un fait exceptionnel." In the course of their experiments Héricourt and Richet found that the blood of untreated dogs did endow rabbits with a certain degree of protection from subsequent inoculation with this micro-organism, inasmuch as the course pursued by the disease in the case of these rabbits was distinctly modified, being less virulent and less rapid, but they expressly state that they consider the assumption justified that the blood of dogs inoculated with this *Staphylococcus*, is capable of conferring immunity of a more complete nature than that obtained by using the blood from untreated dogs.

It is sufficiently apparent, therefore, that these experiments of Héricourt and Richet, far from having "no reference to modern serum-therapy," are the original investigations from which the antitoxic treatment of disease by means of blood-serum has directly followed.

The authors conclude this most interesting memoir by expressing the hope that the injection of the blood of an animal endowed with a natural power of resisting a particular disease may possibly be able to protect other animals, not so fortunately endowed, from attacks of this disease. So far, however, this hope has not been realised. In an article entitled "Recent Studies on Diphtheria" (NATURE, August 22, 1895, p. 393), it was pointed out how the natural or race immunity of one animal to a particular disease was not capable of being transferred, by means of its blood-serum, to another animal susceptible to this disease. We read: "This remarkable circumstance has been once more very clearly demonstrated by Wassermann in the case of diphtheria, to which disease white rats are absolutely immune. In order to test the character of white-rat-serum as regards diphtheria infection, fatal doses of diphtheria toxin were administered to guinea-pigs along with such serum, but in no case did the latter survive, showing that this serum possessed no anti-diphtheritic properties whatever, and was incapable of protecting animals from diphtheria infection."

In connection with the wider application of anti-toxic serum in the treatment of disease, it is interesting to note that already in 1889 Messrs. Babès and Lepp experimented with it successfully in the treatment of rabies, obtaining the anti-toxic serum from a dog rendered artificially immune to hydrophobia. So far, but little advance has been made with it in this direction; since, however, scientific attention has been so attracted to this subject by the success which has attended the use of anti-toxic serum in diphtheria, we may certainly anticipate many fresh developments in its beneficent application.

[1] *Times* Report, September 17, 1895.
[2] Not previously inoculated with dog's blood.

THE MAJOR PREMISS IN PHYSICAL CHEMISTRY.[1]

CHEMISTRY is essentially an inductive science, mathematics is essentially deductive, while physics holds an intermediate position. Yet in our own science, generalisations are reached from time to time, which serve as major premises for syllogistic reasoning. For example, the proposition that each portion of matter has constant weight is at the basis of our knowledge of chemical equivalents as determined by the balance; the isolation of the metals of the alkalis and alkaline earths led to an insight into the nature of salts in general as metallic compounds; and the "periodic law," though not expressed in precise mathematical language, is a most fruitful generalisation of generalisations.

Physical chemistry, following the logical methods already so largely adopted in physics, is characterised by a readiness to use the major premiss. Instead of making a separate experiment to answer each question of fact, the conclusion may often be reached on theoretical grounds, in the same sense as an engineer may demonstrate the stability of the structure he has designed, or the movements of a newly invented machine. What, then, is the leading major premiss in modern chemistry? and what shall be the conditions of fruitfulness?

The doctrine of energy, as based upon thermo-dynamics, embraces the two laws of conservation and correlation; first, energy (while convertible from one form to another) is constant in amount; second, while work may be wholly converted into heat, only a definite fraction of heat can be converted into work. To specify more clearly, if a quantity of heat, H, is received at temperature T (from absolute zero), and if this is converted into work as far as possible by any ideal process until there remains the quantity H′ at temperature T′, then the simple theorem holds that the two quantities of heat are proportional to the two temperatures; and of course the difference between heat received and heat remaining (that is, the work) is proportional to the difference in temperature. Or in algebraic language,

$$H : H' :: T : T'$$
$$H : H-H' :: T : T-T'$$
$$\text{Work}, = H-H' = \frac{T-T'}{T}.H$$

This equation shows what *fraction* of the heat may be converted into work, under the most favourable conditions; namely, the fall in temperature divided by the absolute temperature at which the heat is supplied.

My present purpose is to present this topic in its bare outlines, and with the greatest simplicity possible. Those who wish to follow the deductive reasoning in detail must use the notation of the calculus, in accordance with the following steps. Combining the formula for the total work (as implied in the first law) with that for work derived from change of temperature (the second

[1] Abstract of a paper prepared by request, to introduce the topic of Physical Chemistry, for the American Association for the Advancement of Science. Read September 2, 1895. (Reprinted from *Science*.)

law), we deduce a differential equation for the work obtained or required in isothermal changes. The change under consideration may involve external work, as when a vapour or gas is generated against atmospheric pressure; or it may be internal work of different kinds, as when the molecules are endowed with increased kinetic energy in volatilising, or when a compound is decomposed into its constituents, with increased potential energy.

A somewhat difficult but important paper by J. Willard Gibbs[1] treats of the equilibrium of heterogeneous substances, giving deductions from the two laws of thermo-dynamics, which in turn become major premises for a host of further deductions; so broad, indeed, are the propositions of Gibbs, that the distinctions between chemistry and physics do not appear; there may be two "heterogeneous substances" of like chemical nature, as water and its vapour; there may be three chemical bodies, as limestone with the lime and the carbon dioxide obtained by ignition; or there may be several physical mixtures, as solution of water in ether, solution of ether in water, and the mixed vapour resting upon both liquids. Now, a little consideration will show the importance of knowing when equilibrium is established, for this is equivalent to saying that no further action can take place; the solution is saturated, no longer acting upon the salt; or the gas which has been generated under pressure is no longer evolved. When a change takes place spontaneously, as when I drop a stone, or mix sulphuric acid with water, heat is developed from some other form of energy. To reverse the process, work must be done. The conversion of heat into work is limited by natural law; when a given change implies the doing of work, and that work is forbidden by the terms of our major premise, the change is impossible, equilibrium prevails.

"Osmotic pressure" in dilute solutions is analogous to the pressure of gases; the Gay-Lussac-Marriotte law, with slight modification of terms, applies to molecules in the liquid state. If work is required to diminish the volume of a gas by means of pressure, work is likewise required to diminish the volume of a body in dilute solution, whether the solvent be removed by evaporation or by freezing. Boiling point and freezing point of the solvent are changed by the presence of the dissolved body. The agreement of observed facts with theoretical deductions has led to important methods of determining molecular weights, while the apparent discrepancies in the case of electrolytes have proved an important argument for the doctrine that these compounds are dissociated into their ions.

The mutual indebtedness of technology and pure science has already been pointed out. Manufacturing processes afford many examples of change which are not carried to completion; it is important to know how far the operation can be improved to afford a larger yield, a purer product or less waste. Combustible gases issue from the blast furnaces. There is still a great reducing power in this mixture of carbon monoxide with carbon dioxide. Can it be utilised by enlarging the furnace? Immense furnaces were built in order to secure a larger yield of iron, but the results were disappointing. The law of mass action shows that the equation

$$Fe_2O_3 + 3CO = 2Fe + 3CO_2$$

is limited by certain conditions of equilibrium, and that the ratio of the two oxides of carbon could not be greatly improved over that already secured in practice. The expense of a technological experiment might have been saved, had the indications of mathematical chemistry been heeded.

What hopeless confusion seems to prevail in our present knowledge of solubilities; yet how important in the separations required for chemical analysis. Here, again, we deal with questions of equilibrium. Will work be done at the expense of heat or not?

There are two special difficulties in the general application of thermo-dynamical principles: first, the minor premise is often wanting; and, second, the mathematical form of reasoning is often difficult for the best laboratory workers. Among the published data of thermo-chemistry, some have been determined directly, some indirectly; it is often difficult to find the data desired, or to judge of their accuracy. A critical compilation of all available thermal data, conveniently arranged for reference, with at least some indication of the probable errors, would be very desirable. Many such data might be computed indirectly from experimental determinations of equilibrium. Many empirical equations have been computed, showing solubility as a function of temperature. Who will trace the correlation among such, and thus add a large chapter to thermo-chemistry? What genius shall discover that form of mathematical function that shall substitute rational for empirical equations with a clear interpretation for each constant required? "But this work is mathematical rather than chemical," you will say. Yes, it is applied mathematics; and mathematicians (not being chemists) are not likely to undertake such a task for us, unless we ask their counsel and aid. Specialisation is inevitable; yet by too arbitrary a specialisation, we may inadvertently lose the very help we need. Again would I emphasise the fruitfulness which follows a "cross-fertilisation of the sciences" (*Journ. Amer. Chem. Soc.*, 15, 601 (1893). Judging from the advances recorded in late years, especially in the *Zeitschrift für physikalische Chemie*, it is safe to predict great developments for the rising generation. I heartily echo the sentiment that we need more data; yet great stores of observations upon record have not yet been coordinated and put to use. Ostwald, desiring to know the influence of free iodine upon a reduction process, made three series of determinations (twenty-four in all) from which he concludes that the influence is *not* proportional to the mass. It was no part of his purpose to discover what the law of retardation is; but others might well follow out this clue, using also the data supplied by Meyerhoffer, and supplementing these with further experiments if needed. A glance at the literature of solubilities, and the lack of rational formulæ to express broad generalisations, may convince us that a great mine, with abundant ore "in sight," is awaiting development; or, rather, that ore has been run through a stamp-mill to extract half the gold, while fully half still remains in the tailings, awaiting more perfect methods of treatment.

Much may be learned from the systematic habits of the astronomer, dividing his work among the several observatories in a spirit of helpful co-operation, and assigning the labour of computation to those who are fitted thus to follow the lead of others. What better service can we do for the University student than to set before him some of the problems in mathematical or physical chemistry that require patient toil, and give him the pleasure of assisting in their solution by the use of logarithms and squares? What is more practical than to utilise any service he can render?

In conclusion, I beg leave to suggest the appointment of a joint Committee (representing Sections A, B and C of the American Association) to consider the feasibility of striving towards the following ends:

(1) The compilation of all reliable data of physical chemistry in convenient form for reference, distinguishing those determined directly from those calculated indirectly.

(2) The calculation of empirical formulæ, to combine any series of data, when some better form of generalisation is not already at hand.

(3) The preparation and use of rational formulæ, wherever possible, to deduce the natural constants from series of observations, and to express the conditions that may be expected to hold between observations of different kinds.

(4) The organisation of a band of volunteer compilers and computers from among advanced students, who (with the counsel and aid of their instructors) may assist in the work of compiling data and computing formulæ.

While the time did not seem ripe for the appointment of such Committee at the late meeting of the A. A. A. S., the writer would be pleased to receive any further suggestions from those interested, regarding the points noted above.

ROBT. B. WARDER.

[1] *Trans.* Conn. Acad., 3, 108, 343 (1874-78). See also, *Amer. Jour. Sci.* [3] 16, 441 (1877); 18, 277 (1878).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At the 160th meeting of the Junior Scientific Club, held on Wednesday, November 17, the following officers for next Term were elected:—President, E. C. Atkinson; permanent treasurer, D. H. Nagel; treasurer, N. V. Sidgwick; biological secretary, R. Warren; chemical secretary, H. P. Stevens; editor, A. W. Brown; committee, R. A. Baddicom, M. Hesketh, T. J. Garstang. It was announced that Prof. W. Ramsay had consented to deliver the fifth Robert Boyle Lecture in the Summer Term, 1896.

CAMBRIDGE.—The late Mr. James Carter has bequeathed his collection of fossil Crustacea, on which he was a recognised authority, to the Woodwardian Museum. A portrait of the late

T. Sterry Hunt, Hon. LL.D. of the University, has been presented to the same Museum by Mr. Douglas, of New York.

The Walsingham Medal, given annually by the Lord High Steward for an essay on a biological subject, has been awarded to Mr. I. L. Tuckett, Fellow of Trinity College. Essays for the next award are to be sent in to Prof. Newton, by October 10, 1896.

Dr. Joseph Griffiths has been appointed an Examiner in Surgery.

The Special Board for Medicine propose a new scheme for the degree of Master in Surgery, whereby the degree will be open to M.A.s and B.C.s who have made contributions of sufficient merit to the advancement of the science or art of surgery.

Prof. J. G. McKendrick, F.R.S., has been appointed an Elector to the Chair of Physiology, in the place of the late Prof. Huxley.

A grant of £50 has been made by the State Medicine Syndicate to the Department of Pathology, in aid of the course of bacteriology there given.

The Agricultural Science Syndicate report an increase in the number of candidates for the University's diploma in agriculture. All of the candidates at the recent examination were trained in Cambridge, and one of them obtained the silver medal of the Royal Agricultural Society. Seventeen students, all of them members of the University, are now attending the courses provided in the sciences bearing on agriculture. The fees for the examination are not yet sufficient to meet the expenses.

THE Calendar (1894-95) of the Imperial University of Japan, which has come to hand from Tokyo, should be seen by all who desire to know something about the history of that University, and the work that is being done. The number of professorial chairs in the several Colleges appears surprisingly large to those who are not familiar with the character of the University. There are twenty-three chairs attached to the College of Medicine, twenty-one to the College of Engineering, seventeen to the College of Science, and twenty to the College of Agriculture, not to mention those in the Colleges of Law and Literature. From each of the Colleges valuable memoirs on special researches have been issued, and the University seems to be carrying out the objects of its founders, viz., "the teaching of such arts and sciences as are required for the purposes of the State, and the prosecution of original investigations in such arts and sciences."

MR. WILLIAM TATE, of the Royal College of Science, South Kensington, has been appointed Professor of Chemistry at the Civil Engineering College, Sibpur, Calcutta.

PROF. R. A. SAMPSON has been appointed to the chair of Mathematics in Durham University, vacated by the resignation of the Rev. R. J. Pearce.

THE parts of the University of Virginia destroyed by fire are being rebuilt. *Science* states that reconstruction of the Rotunda, the central building of the group recently destroyed, has already been begun. The necessary money to do this, about £16,000, has been practically subscribed. It is proposed to build a general academical building costing £18,000, a physical laboratory costing £6000, a building for mechanics and engineering costing £6000, and a building for the law school costing £4000. Governor O'Ferrall has promised to recommend in his message to the State Legislature a prompt and liberal appropriation to repair the losses of the school, and it is hoped that £40,000 will be received from this source. Appeals are being made to friends of the University and of education to contribute to the rebuilding and enlargement of the University.

The annual meeting of the National Association for the Promotion of Technical and Secondary Education was held on Tuesday, the Duke of Devonshire being in the chair. After the eighth annual report of the Association, presented by Sir Henry Roscoe, had been adopted, the Duke of Devonshire opened a conference of representatives of technical education committees of county and borough Councils. The subjects discussed were evening continuation schools, the award and tenure of scholarships, and trade and technical classes.

SOCIETIES AND ACADEMIES.

LONDON.

Institution of Civil Engineers, December 3.—Sir Benjamin Baker, K.C.M.G., President, in the chair.—The Influence of Carbon on Iron, by Mr. John Oliver Arnold. This paper embodied the results of researches undertaken by the author primarily to determine whether, at high temperatures, the carbon still remained in combination with the iron. A series of eight 3-inch square crucible-steel ingots, ranging in carbon between 0·08 per cent. and 1·47 per cent., the total impurities other than carbon averaging 0·2 per cent., were hammered and rolled to $1\frac{1}{16}$ inch diameter. They were then submitted to chemical, mechanical, microscopical, thermal, and magnetic tests, in three standard physical conditions, namely: normal, or cooled in air; annealed, or very slowly cooled; and hardened, or very rapidly cooled. The differential analyses for carbon confirmed the conclusion arrrived at by the author in a previous research, that the hard plates of Sorby's laminæ consisted of pure crystallised Fe_3C; and under certain conditions contained practically the whole of the carbon present in the steel. The mechanical tests showed that in normal steels the tenacity increased with carbon up to 1·2 per cent., a further addition of carbon causing a diminution in the stress. The ductility of normal steel diminished with the carbon; the elongation with 0·1 per cent. of carbon being 47 per cent., and at 1·5 per cent. 3 per cent. on 2 inches. Under compression the softness of normal steel decreased with the carbon until 0·9 per cent. of that element was present. Annealed steels under compression indicated a maximum hardness at 0·9 per cent., and were distinct softer than the normal metals. Steel with 1·5 per cent. of carbon was softer than iron containing 0·1 per cent. In hardened steels the rigidity of the metals increased enormously as the carbon rose. The microscopical investigation showed that pure iron consisted of cubic and octahedral crystals. The general results of the microscopical examination sustained the theory that the hardness of quenched steel was due not to a hard allotropic modification of iron, but to a definite sub-carbide corresponding to the formula $Fe_{24}C$. The magnetic observations on hardened steels had led the author to the conclusions that (1) the magnetic permeability varied inversely as the carbon present; (2) the permanent magnetism was directly proportional to the carbides of iron present; and (3) in iron containing between 0·1 per cent. and 0·9 per cent. of carbon the permanent magnetism was directly proportional to the sub-carbide of iron present. The author based the existence of a sub-carbide of iron, possessing the formula $Fe_{24}C$, to which the phenomena of hardening and tempering were due, on the following experimental facts: (1) the well-marked saturation points in the micro-structure of normal, annealed, and hardened steels; (2) a sharp maximum in a curve, the co-ordinates of which were heat evolved or absorbed at the carbon change point, Ar. 1, and the carbon percentage; (3) a point in the compression curve of hardened steels at which molecular flow ceased; and (4) a sharp maximum in a curve, the co-ordinates of which were the carbon percentage and permanent magnetism in hardened steels.—The Dilatation, Annealing, and Welding of Iron and Steel, by Mr. Thomas Wrightson. This paper dealt with investigations of some of the physical changes which occurred in iron during its passage from the homogeneous molten state to the solid and more permanent condition. With regard to the alleged floating of solid iron upon molten iron of the same kind, the author had found that if the piece of solid iron was lowered into the liquid metal by means of an iron fork, it always descended with the fork, but in a few seconds left the prongs and floated to the surface. For some time the sphere continued to rise above the surface until, at such a temperature that it melted, it quickly joined the molten metal. On first sinking the ball proved itself to be denser than the liquid iron. It then expanded and became considerably less dense than the liquid; and lastly, a reversal took place and the ball in melting became of the same density as the liquid. The assumption that dilatation was continuous and uniform during the passage from the liquid to the solid state was therefore erroneous. In order to eliminate the errors due to the emergence of the floating body above the surface of the molten metal, the author used for subsequent experiments an instrument by which the specific gravity of a 4-inch cast-iron ball, completely submerged in the metal, could be observed and continuously recorded. A specimen of the record obtained from the apparatus was given. Experiments upon grey Cleveland iron showed that the specific gravities of the cold solid iron, molten iron, and of plastic iron, were 6·95, 6·88, and 6·50 respectively; and that in passing from the solid to the plastic condition, the iron underwent an increase of volume of 6·92 per cent., followed by a quick contraction as it became liquid. The order of experiment was afterwards reversed, and the change of volume was measured as the molten iron solidified. Into two spherical moulds of dried

loam, 15 inches in diameter, was poured in one case Cleveland white-iron, and in the other Cleveland grey-iron. The fluid metal first entirely filled the mould. An expansion of the outer layers then took place as the metal became plastic, the diameter of the ball therefore increasing. The liquid interior, not having commenced to expand, sank in the hollow shell formed by the cooling and expanding layers of the outside, and thus formed a cavity at the top, which was shown in a photograph of the cross-section of the ball. The metal round the inner surface of the top cavity then hardened, and the interior liquid metal expanded gradually towards the centre; and, by its pressure on the soft outer envelope, also tended to increase the diameter of the ball. This action continued until the outer layers arrived at such a temperature that they should contract; when a contest arose between the contracting force of the fast-thickening outer layers and the expanding force of the interior as it in turn became plastic. When these forces balanced each other, further expansion was arrested. After this point in the cooling had been reached, the outer layers contracted as far as their condition wou' allow, but not to the full natural extent, as, while the outside was in a state of tension owing to the swelling of the interior, fresh layers of plastic and solidifying metal had been built up in the interior. By the time contraction had commenced, these had formed an arch of many courses under different degrees of tension; and such a structure tended to prevent the free contraction of the whole mass. The interior of this enlarged vessel then contracted and drew away principally from the upper part owing to the mass of plastic iron tending to gravitate to the bottom of the ball. The results of further experiments on the buoyancy of solid rolled low-carbon steel showed that it followed the same law as cast-iron. It appeared, therefore, that the physical changes from liquid to solid, as from solid to liquid, were similar in grey-iron, white-iron, and low-carbon steel. In view of the apparent analogy between the expansions of cast-iron in cooling from the liqu' d to the plastic condition and the expansion of water in cooling from 4° C. to 0° C., the author had undertaken experiments to ascertain whether the welding of iron could be attributed to similar action to that producing regelation in ice. To identify the two phenomena, it must be proved that the surface of the iron at the moment of welding contracted with increase and expanded with decrease of temperature. But as, according to the reasoning of the late Dr. James Thomson, matter possessing this property m ist also be cooled by impact or pressure, the identification would be complete, if this collateral property of the cooling of welding iron under pressure could be demonstrated. In the author's experiments, which were carried out at the Mint, with the aid of Prof. Roberts-Austen, the temperature at the welding surface of iron heated in an electric-welding machine was taken by a Roberts-Austen recording pyrometer. The results were given of a series of five experiments, in three of which a fall of temperature, ranging between 19° C. and 57° C., had resulted from the application of pressure, at temperatures of between 1300° C. and 1420° C. The thermal expansion of iron was therefore negative between 1300° C. and 1420° C. The theory of regelation in ice was founded on the fact that the melting-point was lowered by pressure. This held good also for iron, in which case, however, there were increasing degrees of mobility between the temperature of 1400° C. and that of melting wrought-iron, 1600° C. When pressure was applied to a bar, *e.g.* at 1400° C., not only was the melting-point lowered, but the mobility of all lower temperatures within the critical condition was increased.

Chemical Society, November 21.—Mr. A. G. Vernon Harcourt, President, in the chair. The following papers were read:—The influence of temperature on refractive power, and on the refraction equivalents of acetylacetone and of ortho- and para-toluidine, by W. H. Perkin, senr. The author ascribes the discrepancies between his own and Brühl's values for the refraction equivalents of acetylacetone, the toluidines, &c., at high temperatures, to experimental error in the use of Brühl's refractometer.—The evolution of carbon monoxide by alkaline pyrogallol solution during absorption of oxygen, by F. Clowes. The author has determined the experimental conditions regulating the evolution of carbon monoxide during the absorption of oxygen by pyrogallol solution, and details the precautions to be taken for the accurate estimation of oxygen by the absorption method.—The composition of the limiting explosive mixtures of various combustible gases with air, by F. Clowes. The compositions of the limiting explosive mixtures of air with methane, hydrogen, carbon monoxide, ethylene, water-gas, and coal-gas are very different; the narrowest limits are observed in the case of methane, the widest in that of hydrogen.—Note on the estimation of butyric acid, by W. H. Willcox.—Some derivatives of anthraquinone, by E. Schunck and L. Marchlewski. The three isomeric methylpurpuroxanthins and several of the ethers of anthraquinoneoxime have been prepared. — Efflorescence of double ferrous aluminium sulphate on bricks exposed to sulphur dioxide, by D. Paterson. The white asbestos-like efflorescence which appears on bricks exposed to sulphur dioxide, has the composition $Al_2(SO_4)_3$, $FeSO_4$, $24H_2O$, and is evidently identical with a salt found in volcanic regions.

Entomological Society, December 4.—Prof. Meldola, F.R.S., President, in the chair.—Mr. S. H. Scudder, of Cambridge, Mass., U.S.A., was elected an Honorary Fellow to fill the vacancy caused by the death of Prof. C. V. Riley.—The Secretary read a copy of a letter of condolence which he had written, by the direction of the Council, to the Entomological Society of France on the death of their President, M. E. L. Ragonot, and he also read the letter in reply from the Secretary of the Entomological Society of France.—Mr. R. Adkin exhibited a specimen of *Mesogona acetosellæ*, taken at Arlington, Sussex, in October 1895. It was stated that this was the first recorded capture of this species in Britain.—Mr. G. T. Porritt exhibited an example of *Halesus guttatipennis*, taken at Lye, Worcestershire, in November 1889. It was believed to be the third British example. Mr. Porritt also exhibited a series of *Mania typica*, showing a curious malformation in all the specimens. He stated that about one-third of a large brood had emerged in exactly the same form, having the wings only half developed, but with the markings clearly defined. Mr. Tutt and Mr. McLachlan referred to similar malformations in *Agrotis tritici* and *Hadena chenopodii*.—Mr. Goss read a communication from Mr. Sidney Crompton, of Salamanca, Tenerife, announcing the capture there by Mr. Hammerton of two specimens of *Diadema misippus*, a species of butterfly not previously recorded from Tenerife. Mr. Crompton said the specimens were in such fine condition that they must have been introduced into Tenerife in the larval or pupal state, and emerged there. Mr. Hampson, Prof. Meldola, and Mr. Osbert Salvin, F.R.S., made some remarks on the distribution of the species.—Mr. Champion read a paper entitled, "On the Heteromerous Coleoptera of St. Vincent, Grenada, and the Grenadines."—Mr. Kenneth J. Morton communicated a paper entitled, "New or Little Known Palæarctic Perlidæ."

Zoological Society, Nov. 19.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—A letter was read from Mr. J. H. Gurney, respecting a kingfisher (*Alcedo beavani*) which had been lately ascertained to be a permanent resident in some parts of Ceylon.—Mr. Sclater gave a short account of the principal animals he had noticed in the Jardin d'Acclimatation and Jardin des Plantes at Paris during a recent visit.—Mr. Sclater exhibited and made remarks upon the skin of a zebra from Nyasaland, obtained by Mr. R. Crawshay, and a remarkably fine pair of horns of a male Livingstone eland (*Oreas canna livingstonei*), which Mr. H. H. Johnston, C.B., had offered for the Society's acceptance. The animal had been shot by one of Mr. Johnston's hunters, in 1893, between Zomba and Lake Chilwa.—Colonel L. H. Irby exhibited and made remarks on two British-killed specimens of the greater bullfinch (*Pyrrhula major*).—Mr. W. T. Blanford, F.R.S., exhibited and made remarks on skins of *Capra sibirica* and of *Ovis ammon*, killed by Major Cumberland in the Altai mountains.—A communication was read from Mr. Swale Vincent, containing contributions to the comparative anatomy and histology of the supra-renal capsules. In the present paper Mr. Vincent described the naked-eye and microscopical anatomy of the supra-renal bodies in the different orders of fishes. He was inclined to the view that supra-renal bodies are present in all the Elasmobranchii, Holocephali, Ganoidei, and Teleostii, and probably also in the Dipnoi. The supra-renal bodies of fishes were in their essence "secreting glands," as the mammalian organ was now supposed to be. There was no relation whatever, in Mr. Vincent's opinion, between the supra-renals and the lymphatic head-kidney. In the great majority, at any rate, of Teleosteans they were both present in a well-developed condition.—Mr. Gerard W. Butler read a paper on the complete or partial suppression of the right lung in the Amphisbænidæ, and of the left lung in snakes and snake-like lizards and Amphibians. The author gave particulars as to the relative development of the right and left lungs in a large number of Amphisbænidæ and other snake-like lizards and snakes and limbless Amphibians,

which appeared to constitute a representative series, and found that, so far as the species on his lists were concerned, it was an invariable rule that in the Amphisbænidæ the right lung was the smaller, and usually rudimentary or absent, while in all other cases of inequality it was the left lung which was the smaller.—Mr. W. Saville Kent read some observations on the frilled lizard (*Chlamydosaurus kingi*) of Western Australia. After describing the peculiarities of this reptile, Mr. Saville Kent stated that he was inclined to regard it, if not as a surviving representative of the Dinosaurian reptilia, as, at any rate, a most interesting and anomalous lacertilian type that inherited its characteristic bipedal method of progression from that extinct group. Mr. Saville Kent's paper was copiously illustrated by photographs taken by him from life of *Chlamydosaurus* in its bipedal running and other characteristic attitudes, and also by specimens which had been mounted in strict accordance with these photographs.—Two communications were read from Dr. A. G. Butler, on a small collection of butterflies made by Consul Alfred Sharpe at Zomba, British Central Africa, and on a collection of Lepidoptera recently collected in Eastern Central Africa by Mr. G. F. Scott Elliot.—A communication was read from Mr. G. S. West, on the buccal glands and teeth of certain poisonous snakes. The author showed that in the Opisthoglyphous snakes the poison-gland is very variable both in form and extent, and that its duct opens into a cavity formed by muscular folds surrounding the grooved tooth. This opening is always towards the outer side of the grooved tooth, and situated either at its base or but a short distance from it, and the parts were shown to be so related that the loss of the tooth does not cause any injury to the duct. The reserve teeth were shown to be in no way connected with the duct until called upon to replace teeth that had been lost. The epithelium of the distal portion of the duct was shown to be of a secretory nature, the cells being mucus-secreting, similar to those forming the lining epithelium of the mouth. In the *Hydrophiinæ* the poison-gland was shown to be more or less free from the superior labial, and to consist of a large number of longitudinally-disposed tubules converging anteriorly towards a central poison-duct. There were two large poison-fangs situated almost side by side at the anterior extremity of the maxilla. The duct when approaching the region of the teeth became slightly sinuous and suddenly enlarged, enclosing a cavity into which there projected two muscular cushions, one in front of the base of each tooth, and it was through the vertical slit between these that the poisonous secretion passed from the duct to the grooves of the poison-teeth.—A communication was read from Mr. William H. Ashmead, containing a report upon the parasitic Hymenoptera of the Island of Grenada, comprising the families Cynipidæ, Ichneumonidæ, Braconidæ, and Proctotrypidæ. This paper enumerated as occurring in Grenada 183 species of the families named in the title, and described 128 of them as new. Of those previously known the majority had been recently described by Mr. Ashmead as found in the neighbouring island of St. Vincent. The Cynipidæ were all parasitic forms, there being apparently a total lack of any gall-making forms of the family in the island.

Geological Society, November 20.—Dr. Henry Woodward, F.R.S., President, in the chair.—The following communications were read:—"Additional Notes on the Tarns of Lakeland," by J. E. Marr, F.R.S. This paper was supplementary to one by the author published in the *Q. J. G. S.*, vol. li. (1895). It contained additional notes on Wateredbath Tarn, described Hard Tarn on Helvellyn, a pond of which the outlet had gradually been diverted from a course over screes to one over solid rock; Hayeswater, a lakelet referred to by Dr. H. R. Mill as in some respects intermediate between the mountain-tarns and the valley-lakes; and Angle Tarn, Patterdale, a good example of a plateau-tarn. In the discussion that followed, Dr. H. R. Mill said that as Mr. Marr had found every tarn that he examined to be held in by a barrier of drift, it seemed most likely that most, if not all, of the larger lakes would be found to owe their origin to the same cause. In this connection it was worth mentioning that Prof. W. M. Davis, of Harvard, considered, from the configuration of the larger lake-basins in the district, that they were produced in drift-blocked valleys.—"Notes on the Glacial Geology of Arctic Europe and its Islands. Part i. Kolguev Island," by Colonel H. W. Feilden, with a report on the erratic boulders from the Kolguev beds, by Prof. T. G. Bonney, F.R.S. Kolguev Island, about the size of Norfolk, was about 50 miles from Arctic Russia and about 130 miles south-west of the nearest part of Novaya Zemlya, with soundings not exceeding 30 fathoms between it and Russia, and probably not more than 75 fathoms between it and Novaya Zemlya. It was entirely composed of a vast accumulation of glacio-marine beds. The northern two-thirds of the island consisted of an elevated ridged area with a maximum height of 250 feet. The author had been furnished with notes by Mr. Trevor-Battye concerning the geology of this region. It was inferred from his observations that this elevated region was composed of beds of sand with erratic boulders not less than 80 feet deep, resting on clays—the "Kolguev clays." Mount Bolvana rose as a symmetrical cone above the tundra, detached from the northern plateau, pointing, in the opinion of the author, to the occurrence of marine erosion. The southern portion of the island was tundra, a dead flat of grass, bog, and peat-levels reaching to the sea; good sections of the Kolguev clays were exposed in the gullies traversing it near the sea on the western coast. In the vicinity of the Gobista river the Kolguev beds consisted of clays merging here and there into sands. They were charged with boulders often ice-scratched, indicating continuous deposition in a comparatively deep sea. The beds yielded many shells of arctic mollusca, such as *Saxicava arctica*, *Mya*, &c., apparently dispersed from top to bottom. The ice-pack had forced many fragments of semi-fossil wood on to the shore, no doubt worked up from a bed immediately below sea-level. No deposit was met with in Kolguev Island precisely similar to what is called "till" in Scotland, though there were many boulder clays in Britain which were in no measure superior in toughness to those of Kolguev; for instance, those of the Yorkshire coast, and the chalky boulder clays of Norfolk. It is suggestive that all the glacial deposits met with by the author in arctic and polar lands (except the terminal moraines now forming above sea-level) should be glacio-marine beds. Prof. Bonney, in his report, described the rocks brought home by the author. A discussion followed, in which Mr. Marr, Mr. Trevor-Battye, Mr. Boulger, Dr. G. J. Hinde, Dr. Gregory, and the Rev. Edwin Hill took part.

CAMBRIDGE.

Philosophical Society, November 11.—Prof. J. J. Thomson, President, in the chair.—The following communications were made:—A method of measuring the hysteresis of iron, by Mr. G. F. C. Searle. A bar of iron is placed in a solenoid, and the magnetising current flowing in the solenoid also passes through the fixed coils of an electrodynamometer. This current can be reversed. A secondary coil is wound on the iron, and the current induced in it by the variation in the magnetic induction passes also round the suspended coil of the electrodynamometer. Thus if H is the magnetic force due to the solenoid, and B is the magnetic induction in the iron, the current in the fixed coils is proportional to H, and the current in the suspended coil is proportional to dB/dt, provided that B changes so slowly that the effects due to self-induction in the secondary circuit are negligible. The couple experienced by the suspended coil at any time is proportional to HdB/dt, and thus the angular momentum acquired during a double reversal of the magnetising current is proportional to $\int HdB$ or to $4\pi \int HdI$, where I is the intensity of magnetisation. Thus the "throw" of the spot of light reflected from a mirror attached to the suspended coil is proportional to the energy lost in hysteresis during the double reversal. Experiments were shown to illustrate the manner in which the method could be applied to investigate the effects of strain and temperature upon the hysteresis in iron.—The form of cubic surfaces containing twenty-seven real straight lines, by Mr. W. H. Blythe. The paper was illustrated by two plaster models. The first represented the general case of a cubic surface having twenty-seven real straight lines, the position of the lines being shown by threads. The second was a rough model of the special form having a tangent plane at infinity, which contains three of the lines. It is constructed to show the position of the remaining twenty-four straight lines, which form a symmetrical system.—Expansion produced by the electric discharge, by Miss Martin. At the suggestion of Prof. Thomson, the experiments of Meissner on the expansion of gases by the electric discharge were repeated by Miss Martin. After some preliminary experiments, in which the results obtained differed from those of Meissner, new apparatus was set up, an exact copy of Meissner's, consisting of an ozone generator with a sulphuric acid pressure-gauge attached; the two tinfoil coats of the generator were connected with the terminals of an electrical machine. In Meissner's original experiments it was

thought that the precaution of never separating the terminals of the electrical machine further than by a small fraction of the distance between the coats of the generator would ensure the absence of discharge between the coats; and in the conditions adopted, Meissner observed that when discharge took place by the passage of a spark between the terminals, there was a temporary increase of pressure; the effect being most marked in the case of CO_2, and least marked in H. In Miss Martin's repetition of the experiments, the generator was put in a dark box, provision being made to let the gauge and the space between the coats of the generator be seen. It was then established that in no case could any deflection of the gauge be seen, except when luminosity could be detected in the generator. It was further observed that when the discharge passed through CO_2 a permanent contraction was produced. The experiments have been repeated by Prof. Thomson, and he finds that if wet CO_2 is used, the effect is more marked; but if carefully dried CO_2 is used, no contraction is produced.

PARIS.

Academy of Sciences, December 2.—M. A. Cornu in the chair.—On the extension of the ideas of Galois to the theory of differential equations, by M. Émile Picard.—Remark on a memoir, by M. Jaumann, entitled, "Longitudinal Light." A note by M. H. Poincaré. The author derives equations, from those found by M. Jaumann, which indicate properties for cathode rays not agreeing with facts, and hence considers that modifications are needed in the hypotheses put forward in the memoir.—On the presence of sodium in aluminium prepared by electrolysis, by M. Henri Moissan. It is shown that electrolytic aluminium contains in general from 0·1 to 0·3 per cent. of sodium, and that the presence of this impurity renders the metal easily attacked by water. Aluminium should always be used alone and pure, as it readily forms electric couples with every other metal, and is then easily attacked by water.—On the origin of argon and of helium in gases disengaged by certain sulphurous waters, by MM. L. Troost and L. Ouvrard. It is shown that, though argon is generally present in waters, helium is only found in certain mineral waters, and does not probably owe its origin to the atmosphere, but to the rocks through which the waters have percolated. M. Bouchard added some remarks on the therapeutic value of helium and argon, and supported the view that these gases have no action on the economy, but admitted that the metals present in helium containing minerals might have medical action when present in minimal amounts.—Structure of the mesenteric ganglia of the pig, by M. L. Ranvier.—Observations on Perrine's comet (16 November, 1895) made with the great equatorial at Bordeaux Observatory by MM. G. Rayet and L. Picart. Note by M. G. Rayet.—M. Ch. V. Zenger, in a note entitled "Studies in molecular physics," sets forth a very simple relation between the density and specific heat of chemical elements, and indicates a new view of the genesis of the elements.—Observations of Swift's comet (1895, August 20) made with the great telescope, and of Perrine's comet (1895, November 16) made with the 0·25m. equatorial at Toulouse Observatory, by M. Rossard.—Note on the construction of the calendar, by M. A. Auric.—On Lamé's equation, by M. G. Floquet.—On the extension of Cauchy's method to systems of equations to the derived partials of any order whatever, by M. J. Beudon.—On the functions of two real variables and on the motion of an arbitrary function, by M. Émile Borel.—On orthogonal systems, by M. Paul Adam.—On a new determination of the ratio between the electrostatic and electromagnetic units, by M. D. Hurmuzescu. The value found gives

$$v = 3{\cdot}0005 \times 10^{10} \text{ to } 3{\cdot}0020 \times 10^{10}.$$

—Relation between the intensity of light and the chemical decomposition which it produces; experiments with mixtures of ferric chloride and oxalic acid, by M. Georges Lemoine. The chemical decomposition of a mixture of ferric chloride and oxalic acid is proportional to the luminous intensity.—On the presence of argon and helium in a natural source of nitrogen, by M. Ch. Moureu.—Experimental determination of the agglutinating power of oils, by M. Louis Campredon.—On a chromium amalgam and some properties of metallic chromium, by M. J. Férée.—On a method of synthesis of complex amides, by M. Albert Colson.—New examples of the superposition of optical effects of asymmetric carbon atoms, by MM. Ph. A. Guye and Ch. Goudet.—On a zoological exploration of Corsica, by M. Louis Roule.—On the anatomy and systematic position of compound Ascidians of the genus *Sigillina*, Sav., by M. Maurice Caullery.—On the accumulation of sugar in beetroots, by M. L. Maquenne.—The pliocene and quaternary glaciers of Auvergne, by M. Marcellin Boule.—On the geology and "tectonique" of the Central Caucasus, by M. E. Fournier.—On two new forms of quartz, by M. P. Termier.—On the effects of the tropical revolutions of the sun and of the moon on the barometric pressure, by M. P. Garrigou-Lagrange.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Congrès de l'Atmosphère 1894, Compte Rendu (Anvers).—Introduction to the Study of Fungi: Dr. M. C. Cooke (Black).—Mensuration for the Use of Schools, &c.: Rev. A. D. Clarke (Rivington).—Modern Microscopy: M. I. Cross and M. J. Cole, 2nd edition (Baillière).—Practical Inorganic Chemistry: Dr. G. S. Turpin (Macmillan).—The Pterophorina of Britain: J. W. Tutt (Hartlepool, Robson).—Elementary Algebra: J. W. Welsford and C. H. P. Mayo (Longmans).—University College, Nottingham, Calendar 1895-96 (Nottingham, Sands).—Compensacion de Declinaciones Magnéticas en la Peninsula Ibérica: Don R. P. de Figueroa (Madrid).—Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbethiere, Dr. O. Hertwig, Fünfte Auflage (Jena, Fischer).—Principles of Metallurgy: A. H. Hiorns (Macmillan).—Macmillan's Geography Readers, Book vii. (Macmillan).—Elements of Geometry: G. C. Edwards (Macmillan).—Essays in Taxation: Prof. E. R. A. Seligman (Macmillan).—Regeneration, a Reply to Max Nordau (Constable).—The Key of the Pacific, the Nicaragua Canal: A. R. Colquhoun (Constable).—Service Chemistry: Prof. V. B. Lewes, 2nd edition (Whittingham).—Physical Measurements: F. C. Weedon (Gill).—Imperial University of Japan, Calendar 1894-95 (Tōkyō).—Handbuch der Mineralchemie: Dr. C. F. Rammelsberg, Zweites Ergänzungsheft zur Zweiten Auflage (Leipzig, Engelmann).—Kurzes Handbuch der Kohlenhydrate: Dr. B. Tollens, Zweiter Band (Berlin, Trewendt).

PAMPHLETS.—Ethnography of the Mullet, Inishkea Islands and Portacloy, Co. Mayo: Dr. C. R. Browne (Dublin).—On Memory and the Specific Energies of the Nervous System: Prof. E. Hering (Open Court Publishing Company).—Spiritual Truth and Common Sense: B. Hodgson (Birmingham, Cornish).—On the Localisation of the Foramina at the Base of the Skull: Prof. E. Fawcett (Bristol, Arrowsmith).

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CONTENTS.

THURSDAY DECEMBER 19, 1895.

THE ORIGIN OF PLANT STRUCTURES.

The Origin of Plant Structures by Self-adaptation to the Environment. By the Rev. G. Henslow, M.A., F.L.S., &c. International Scientific Series. Pp. xii + 256. (London: Kegan Paul, 1895.)

THE present work may be regarded as the second part of the "Origin of Floral Structures," published by the same author in 1888. In that volume Prof. Henslow propounded his Neo-Lamarckian view, that all differences of colour, shape, and size of floral organs have been directly caused by the influences surrounding the plant. The visits of insects, with their constant thrusts and probings, have produced, as a direct result, all the variety of the phanerogam flower.

In the present volume, the same proposition is extended to the vegetative organs of plants, of which the efficient cause of diversity, whether of external or internal morphology, is to be sought in changes in the conditions of life. In this way the author makes studies of the following special cases:—Desert plants, Arctic and Alpine plants, maritime and saline plants, phanerogamous aquatics, subterranean structures, climbing stems and leaves. From a careful analysis of the biological peculiarities of these forms, Prof. Henslow claims to draw strong support for his views.

The Darwinian hypothesis assumes, in the offspring, constant minute variations in all directions from the parent type: those variations that are of service to the plant in its struggle for existence, are perpetuated and increased by natural selection and heredity. Prof. Henslow denies the existence of natural selection altogether: variations in nature, according to him, are never indefinite, but always definite, and, being induced by the change of environment, and the responsive action of protoplasm, they are always in the direction of adapting a plant to its surroundings.

The test of a theory lies in the wideness of its application; and herein exists the great beauty of Darwin's hypothesis. After all these years of severest criticism, no definite proofs have been urged against it; and the best that Prof. Henslow can do is to offer a substitute which, to his mind, furnishes an easier solution to the difficulties of certain selected cases.

Whatever may be the opinion of others, the author himself is sure of his ground. The introduction opens with these words: "Natural Selection plays no part in the Origin of Species." This dictum is not likely to be accepted by the general scientific world without very strong support. The imputation of narrowness of field in Darwin's observations is hardly in good taste, while such headings as "Darwin's Fundamental Error" predispose the mind to a critical attitude.

It is usually agreed that, from the nature of the case, a definite proof of the action of natural selection is difficult, if not impossible, in the present state of our knowledge. This the author of the present volume concedes, and at the same time puts forth arguments against the probability of such proofs being forthcoming. With considerable skill, if with rather superfluous detail, he discusses the manner in which the environment impresses itself upon the anatomy of plants. Of the *inheritance* of such acquired characters there is no proof at all. We are offered instead the "argument of coincidences" and the "cumulative evidence of probabilities, which amounts to a moral conviction." Clearly, before rejecting a well-established and widely applicable hypothesis, something more tangible is required.

In each section of the present volume, Prof. Henslow presents the reader with an interesting picture of the biology of a group of plants. The descriptions would, we think, be clearer if the writer had condensed his quotations somewhat. As it is, the interpolation in the text of long passages—frequently in French—mars the simplicity.

We emphasise this point because of the character of the author's reasoning. He is an exceedingly plausible and persevering casuist; and it is, on that account, all the more desirable that the reader should retain a clear impression of the course of the argument.

To take a specimen of the author's method. In speaking of the frequent hairiness of desert plants, as contrasted with those more favourably situated, Prof. Henslow quotes Mer, to the effect that "*cæteris paribus* hairs are the result of localised extra nourishment." This, he points out, was long ago suggested by Aug. Pyr. de Candolle as the cause of the hairiness of the barren inflorescence of *Rhus Cotinus*, where the nutrition, which would normally be applied to the formation of flowers and seeds, finds a new outlet. So with the hairy filaments of *Verbascum* and other flowers where some of the anthers are barren or suppressed; also, as Masters has pointed out, the hairy outgrowths in many galls.

The "localised extra nourishment" of desert plants the author accounts for in the following manner. There is a characteristic diminution in the size of the leaves in desert plants, due principally to a decrease in the parenchymatous tissues; hence, it is argued, there is an arrested food supply which, "by a compensating process," is used up in the formation of hairs.

To take another instance: the rapid maturing and seeding of plants, in regions of short summer, is traced to the changes which take place in the reserve materials during the low temperatures of the long winter preceding, just as frosted potatoes shoot out quickly in the spring.

We are not sure that, in these attempts to define the exact mode of "the responsive action of protoplasm," the author does not deprive it of more of its independent and unexplained reactions than is justified by our present knowledge.

In a word, each argument, although composed of a chain of neat and plausible propositions, lacks coherence and, somehow, fails to carry conviction. In each change of environment, the protoplasm is, so to speak, induced, by a kind of internal conjuring, to present the very modification of structure which will be of service to the plant under the altered conditions.

It has been pointed out that only isolated cases have been dealt with in this volume; but, for the hypothesis to be acceptable, it must be widely applicable. We should like to learn how the beautifully fashioned hooks

of the seeds of *Martynia* have been formed, or the delicate tracery of the pappus of *Tragopogon*, the insectivorous glands of *Drosera*, the roots of *Acanthorrhiza* which grow upwards and become a thorny hedge around the young plant, or the profusion of thorns upon the palms of moist tropical forests. Although fraught with difficulties, the Darwinian theory embraces all such cases; while that defended by the author requires a new line of argument in each separate instance.

Prof. Henslow is rich in expedients, and is a fearless theoriser. He regards the opposite or decussate arrangement of leaves as the primitive, because of the position of the cotyledons; the sheathing base of *Monocotyledons* and *Umbellifers* is a mark of degeneracy; the heterophylly of *Juniperus* is caused by a variation in the amount of nutriment at the plant's disposal. He suggests that the enlarged watery, subterranean parts of desert plants may be due to the blistering action of the hot sand, and that the thickened cuticle of plants in dry climates may be formed or aided by a deoxidation of chlorophyll by excessive light. Lastly, he explains the fact, observed by Volkens, that the stomata of desert plants are frequently closed in the day and open at night, by a reversal of the ordinary reactions of the guard cells to turgescence. "Perhaps the arrested moisture, due to the check to transpiration, may cause turgescence by day, which closes the slit, while its cessation at night brings about a relaxation."

We confess that Prof. Henslow's views on geotropism are puzzling and disappointing. He denies the existence of negative geotropism; and bases his argument, curiously enough, upon Knight's well-known wheel experiment. Here he discovers a *centripetal pulling* force which causes the stem apex to grow towards the centre of the rotating wheel, and at the same time a *centrifugal pulling* force which causes the root to grow outwards. "Each end of the plant is therefore subjected to what might be called an accelerating 'pulling' force." A moment's consideration will show that there is no such *centripetal pulling* force acting upon the free stem-apex. Prof. Henslow seems to lose sight of the fact that the action of gravity upon parts of plants is directive rather than purely mechanical.

Further, it is not clear why gravity ceases to act upon the apex of *Ranunculus heterophyllus* because it is immersed in water (p. 201)!

There are many points which will exercise the morphologist. Why are the first leaves of water plants regarded as phyllodes? We hardly agree with Prof. Henslow's ideas on the interchangeability of stems and roots in nature, although each may arise from the other endogenously.

Then again, it is difficult to follow the author's description of the vascular system of water plants on pages 145–7. We gather that he regards "spirals" as the only true "tracheæ"; and "vessels" appear to have quite a different meaning. The following is far from clear: "In aquatics the punctated vessels may closely simulate punctated fibres, the chief differences being in the lessened diameter of the latter, and the more or less oblique position of the septa. Then these pass into thin-walled fibres of the same shape, and finally become 'fibrous cells,' when they may contain starch."

We have read the volume with great pleasure, both because of the mass of interesting details of plant biology, and the ingenious piecing together of evidence; nevertheless, we do not think that Prof. Henslow's attempts to reconstitute the theory of evolution are altogether successful. C. A. BARBER.

SOLUTION AND ELECTROLYSIS.

Solution and Electrolysis. By W. C. Dampier Whetham, M.A. (Cambridge: The University Press, 1895.)

UP till the beginning of the present year the English reader had practically only two text-books to guide him in getting some idea of the scope and importance of the Newer Theory of solutions. These were "Solutions," a translation of certain parts of Ostwald's Lehrbuch, and "Outlines of General Chemistry," by the same author. The former gave but an imperfect account of the subject, as it excluded the electrical properties of solutions, and thus the mass of material which groups itself around the hypothesis of electrolytic dissociation; while the latter, although giving a general survey of the theory, dealt with it in but a superficial manner. To these was added, early in the present year, Nernst's "Theoretical Chemistry," and in this book is to be found the best description in English of the present condition of the theory; for although the description is by no means rich in records of actual observations, yet, on account of the neat methods used in dealing with the theory of individual questions, and the comprehensive mode of attacking the entire subject, it is worthy of the attention of all students of physical chemistry.

The book under notice gives a much more detailed survey of the theory as a whole than that found in Ostwald's "Outlines." The mode of treatment is, however, less thorough than that in Ostwald's "Solutions," and has little resemblance to the compact and orderly method used by Nernst.

In his preface the author states that a considerable part of the first six chapters is taken from Ostwald's Lehrbuch, and this is unmistakably evident on reading them through. They deal with solubility, the different kinds of solutions, diffusion and osmotic pressure, freezing-points, and vapour-pressures. The remaining five chapters have much greater claims to originality, and are devoted to the electrical properties of solutions—Faraday's laws, polarisation, the theory of the voltaic cell, the migration and velocity of the ions, electric conductivity and its correlation with other properties, and theories of electrolysis.

The student familiar with the elements of physics and chemistry will have little difficulty in following the information supplied. The author has, in particular, to be thanked for setting out at length the more important applications of thermodynamics to solutions, as these are often a source of worry to the beginner. Many indications are also given of attention to points which are often scantily treated, as in the case of the theory of diffusion, the meaning of osmotic pressure, the theory of the voltaic cell, &c. On the other hand, the treatment of solutions in gases, associated solutions, Beckmann's molecular weight apparatus, &c., is extremely superficial. There-

are also certain points to which attention must be drawn, in view of future editions of the book.

When dealing with plasmolysis (p. 37), the author omits to state that the animal or vegetable cells used must contain living protoplasm, and the reader is led to infer that artificially-coloured, instead of naturally-coloured cells are employed for plasmolytic observations. Although certain stains are known which are not immediately fatal to living cells, there is no record of their use in plasmolytic experiments. It is also made to appear that red blood corpuscles contain a semi-permeable membrane, despite the conclusive observations of Hamburger to the contrary. In connection with this subject, it is misleading to state (p. 38) that De Vries "established the most important generalisation" that solutions of the same molecular concentration are isotonic, for inasmuch as by far the greater number of his solutions were electrolytic, his results clearly contradict this statement. On p. 34, the credit of preparing semi-permeable membranes is given to Pfeffer, whereas M. Traube first described their preparation and properties. As regards the more general treatment of the first section, it is noteworthy that although the solubility of mixed substances is to some extent discussed, no notice is taken of the work of Roozeboom, and Gibbs' phase-rules, which apply to all cases of heterogeneous equilibrium in solution, are not even mentioned.

In the section on electrolysis, some inkling might have been given of the wide field opened up for the verification of the ionic hypothesis by its application to the operations of analytical chemistry. Among smaller points, it may be noted that, on p. 128, potassium platinichloride should be sodium platinichloride, and in a somewhat vague paragraph, on p. 164, we read that the introduction of oxygen, sulphur, or a halogen, which raises the affinity of a weak acid, "has no effect on the affinity of these strong acids." Since the strong acids quoted by the author are hydrochloric, nitric, &c., the student may be pardoned if he is puzzled to understand how the introduction is to be brought about, or what acids would result if it were possible.

A novel feature in a book of this kind is an attempt made by the author to reconcile the Hydrate Theory with the Newer Theory of solutions. Of course it has all along been apparent that the latter does not preclude combination between solvent and dissolved substance. What the upholders of the newer theory assert, however, is that at the present time there is no definite evidence that, in general, such combination exists. An attempt to reconcile the two views should therefore involve a careful study of the experimental data in favour of combination. It is for this reason unfortunate that the author gives but a very brief statement of the results of the extensive work of Pickering in this field.

As an appendix to the book is given part of the list of the conductivity, migration, and fluidity data of solutions compiled by Fitzpatrick for the British Association Report of 1893. For the sake of chemical readers it is to be regretted that most of Ostwald's observations on the conductivity of organic substances have been omitted, since it is in the case of such substances that the close connection between the electrolytic properties of solutions and the chemical nature of the dissolved substances can be most conveniently traced. J. W. RODGER.

THE THEORY OF ALGEBRAIC FORMS.

An Introduction to the Algebra of Quantics. By E. B. Elliott, M.A., F.R.S. Pp. xiv. + 424. (Oxford: Clarendon Press, 1895.)

THE history of the theory of algebraic forms gives a striking example of the fact that the germ of a mathematical doctrine may remain dormant for a long period, and then suddenly develop in a most surprising way. The principles of the calculus of forms are to be found in the arithmetical works of Lagrange, Gauss, and Eisenstein; but the great expansion of the theory, with which we are now so familiar, practically dates from the publication of the papers of Boole, Cayley, and Sylvester, about fifty years ago.

It is well known that the theory of forms has advanced upon two distinct lines: one method being derived mainly from the differential equation of sources, supplemented by generating functions and the theory of equations; the other, from the symbolical representation of a quantic, invented by Aronhold, and applied with such power by Clebsch and Gordan. Until quite lately, the symbolical method might not unjustly claim to be superior in respect of organic unity, as it must still be admitted to be in compactness and geometrical suggestiveness; but the other method has now undergone a remarkable transformation at the hands of Hammond, MacMahon, Hilbert, and others, and has led to results of the highest interest and value, which the symbolical calculus could not easily or naturally supply.

With the exception of three pages, devoted principally to Cayley's hyperdeterminant notation, Prof. Elliott does not refer to the symbolical method. With his reasons for not using it we must reluctantly acquiesce. It is quite true, as he says, that a mere outline of the method would have been worse than useless; and by omitting it altogether, he has been enabled to give a very lucid and thorough account of the subject from one consistent point of view, without that excessive condensation which is so often a defect rather than a merit.

It is not necessary to say much of the earlier chapters, except that, like the rest of the book, they are very clear and pleasant to read; in particular, the proof that every covariant of a covariant is a covariant of the original form is easier to follow than that given by Salmon. It is when we come to chapters vi. and vii., which deal with seminvariants and their annihilators, that the influence of recent discoveries begins to be felt. Thus the notions of *excess* and *extent* are introduced, and the annihilators of invariants and covariants of systems of quantics are indicated.

Chapter viii. discusses generating functions, and is a very good introduction to this part of the subject. It does not profess to be exhaustive; and it is perhaps as well that the author has refrained from giving the detailed reduction of the generating functions for forms higher than the quartic. This would have taken up a good deal of space; and the full discussion for the lower forms, which is given, is quite enough to illustrate the general procedure. The results for the quintic are also stated, and references are given to the memoirs of Sylvester and Franklin, which ought to be easily understood by any one who has mastered this chapter.

Another very interesting chapter follows. This contains Hilbert's proof of Gordan's celebrated theorem, that the number of irreducible concomitants is finite. Compared with Gordan's original proof, this is simplicity itself; and it is unlikely that the demonstration can be essentially improved upon in this respect, although no doubt some simplification in detail may be effected.

Chapters x. and xi. are also well brought up to date. They deal with protomorphs and perpetuants, and the connection of seminvariants with non-unitary symmetric functions. It is needless to say that they are based principally on the researches of MacMahon and Hammond. The deduction of the annihilator of non-unitary symmetric functions of the quantic

$$b_0 x^p + \frac{b_1}{1!} x^{p-1} + \frac{b_2}{2!} x^{p-2} + \ldots + \frac{b_p}{p!}$$

seems rather artificial, as it is made to depend upon the transformation

$$-\frac{\partial}{\partial s_1} = b_0 \frac{\partial}{\partial b_1} + 2b_1 \frac{\partial}{\partial b_2} + \ldots \; pb_{p-1} \frac{\partial}{\partial b_p}$$

But this is a small matter, and the chapters are full of interest. One remarkable novelty is a differential operator which annihilates any rational integral function whatever of the coefficients of a finite quantic. Here is, indeed, a universal solvent. It should be added that the examples at the end of chapter xi. give a synopsis of Stroh's verification of MacMahon's brilliant conjecture that the generating function for perpetuants of degree i is

$$\frac{x^{2^{i-1}} - 1}{(1 - x^2)(1 - x^3) \ldots (1 - x^i)} \ldots (i > 2)$$

The remaining chapters (xii.–xvi.) treat of canonical forms, the binary quintic and sextic, systems of binary quantics, orthogonal invariants, and the ternary quadratic and cubic. The chapter on the quintic and sextic does not go into detail, but gives complete lists of the concomitants, and in particular the explicit forms (supplied by Mr. Hammond) for the quintic $(a, b, 0, 0, e, f)(x, y)^5$. The other chapters do not seem to call for special remark; suffice it to say that they maintain the high standard of those which precede them.

Prof. Elliott states in his preface that the book is an expansion of a course of lectures delivered annually for some years past at Oxford. To this fact, no doubt, may be attributed, in some measure, the lucidity and symmetry of the treatise. Another good feature, perhaps due to the same cause, is the occasional statement of what a theorem does *not* imply. To the well-informed reader this may seem superfluous, but it is by no means so in the case of a learner, who not infrequently reads into a theorem a degree of generality which it does not really contain.

To return to the symbolical method of Clebsch and Aronhold. Prof. Elliott admits that an English work on this calculus is a desideratum; will he not be persuaded to supply this want himself? It would be a great boon to have an English book something after the kind of the Clebsch-Lindemann "Geometrie," including, at least, the theory of plane quadratic and cubic curves, and of surfaces of the second order, with perhaps an introduction to the theory of cubic surfaces. This is, no doubt, a heavy task, but it is well worth attempting; the theory of forms is infinitely more interesting in its geometrical applications than as a mere branch of analysis, and it is here, above all, that the power of the symbolic method shows itself. Such a work would do much to avert the danger of divorcing the theory of forms from analytical geometry; a danger which is encouraged by the present regulations of the mathematical tripos, which place these cognate subjects in two different divisions.

G. B. M.

SURFACE-COLOURS.

Die Oberflächen- oder Schiller-Farben. Von Dr. B. Walter. 1 vol., with 8 woodcuts and 1 plate. Pp. vi. + 122. (Braunschweig: F. Vieweg und Sohn, 1895.)

THIS work is primarily addressed to zoologists, mineralogists, and chemists, appealing in only a subordinate measure to physicists. On this account the mathematical developments most desirable for the physicist are reserved for appendices, while the text itself contains only such matter as is vital to the theory of surface-colours, together with very simple and well-established formulæ given without proof.

The importance to the first-named classes of an acquaintance with the physical basis of these colours immediately appears, says the author, from the facts that, on the one hand, to this class of colours belong the tints of many butterflies and birds, and also those of a series of crystals exhibiting the most gorgeous natural phenomena; and on the other hand, the technologist, if he desires artistically to imitate these colours, must naturally, first of all, obtain a true insight into their manner of production. Now, although this treatise contains no startling additions to our physical knowledge of surface-colours, it may yet be expected to render a most acceptable service to this branch of physics, since in many minds there still linger hazy, or even discordant, conceptions of these colours, and until now no work seems to have appeared devoting to the subject even any approach to an exhaustive treatment.

Of the experiments, which form the basis of the calculations and statements contained in this book, those which are new have been carried out by the author in the State Physical Laboratory at Hamburg.

The first chapter is a brief introduction to the subject of the work. The second and third chapters treat of the surface-colours of colourless materials and of metals respectively. In the fourth chapter, embracing about a third of the entire treatise, the author discusses the dichroic substances proper; solid fuchsine and diamond green, also solutions of these, and fluorescein solution being specially dealt with. This chapter is unusually rich in experimental results. It is pointed out that the body-colour and the surface-colour are only approximately complementary, and are not exactly so, as stated in Haidinger's law. We have also here the following important statement: "The coefficient of reflexion of a particular ray from a given substance depends not only upon the absorption coefficient of the substance for that ray, but also upon its refractive index for the ray in question, the relative importance of these two factors varying with circumstances, so that in the case of the feebly-absorbed rays of coloured substances the refractive index is prac-

tically the sole factor in determining the intensity of the reflected light."

In chapter v. the distinguishing characteristics which separate surface-colours from other classes of colours are noted. The following kinds of colours are treated: (1) body-colours; (2) the colours of turbid media; (3) the prismatic dispersion colours; (4) the spectral colours of the diffraction grating; and (5) the colours of thin plates. With reference to the latter, the author calls attention to the fact that if one changes the polarisation of the incident light used in producing the colours of thin plates, the result is simply a change in the *intensity* of the colours, no change in their *tint* being thereby caused; whereas with surface-colours proper, under the same circumstances, *both intensity and tint* are thereby changed. The body of the work concludes with a sixth chapter, dealing with the occurrence of surface-colours in the animal and mineral kingdoms.

E. H. B.

OUR BOOK SHELF.

Studies from the Biological Laboratories of the Owens College. Vols. i. (pp. 328), ii. (pp. 268), iii. (pp. 286), 1886, 1890, and 1895. (Manchester: Cornish.)

THERE is growing up among us a habit of collecting and publishing reprints of memoirs as "Studies" from this laboratory or from that; and a very excellent habit it appears to us to be. We have known for some years the "Studies from the Morphological Laboratory" of Cambridge; we have seen "Reports" from the Physiological Laboratory of University College, London; "Transactions" from Dundee, edited by Prof. D'Arcy Thompson, and quite recently we referred to the youngest of such publications, viz. the "Linacre Reports" of the zoological work at Oxford, edited by Prof. Ray Lankester.

All such collections serve the useful purpose of indicating the character and amount of work carried out at the various important teaching institutions of the kingdom, and of emphasising the fact that the best teaching work is performed by those engaged in research. It may be objected that the memoirs contained in such "Studies" can be found elsewhere. This is, in general, true; but, nevertheless, such collections help to associate more readily in our minds the workers with their masters and the institutions to which they are attached; and oftentimes it brings together, in a compact form, a series of contributions undertaken with some special object, by different workers it may be, or by one man.

The first volume of these "Studies" from Manchester was published in 1886, the second in 1890, the third during the present year; the last is under the editorship of Dr. Sydney Hickson, the two former by the late Professor. These volumes contain several valuable memoirs, some of which are already classical, such as Marshall's "Segmental Value of the Cranial Nerves," Beard's account of the Branchial Sense-organs, and Melland's contribution to the Histology of Striated Muscle; and to these will have to be added, no doubt, the researches of Marshall and Bles on the Development of the Vascular System, and of the Kidneys in the Frog, Robinson's observations on the Development of the Optic Nerve, Paterson's account of the Origin of the Nerve-plexus of the Limbs, and other embryological papers undertaken at the suggestion of the late Professor.

In addition to these developmental memoirs, those by Fowler on the anatomy of Corals, and by Garstang and by Gamble on the Fauna of the British Coasts, have a permanent value. In the last volume, Milnes Marshall's interesting "Address" at the British Association, dealing with "Recapitulation in Ontogeny," is reprinted.

The absence of botanical research in the later volumes is the more noticeable, as Prof. Marshall Ward contributed to the first volume. We hope that botanical research is not dead in Manchester.

Palæontology is represented by Dr. Hurst's account of *Archæopteryx.*

The quality and extent of ten years' work brought together in these three volumes, bear witness to the energy and influence of the late Beyer Professor; and we may echo Prof. Hickson's prefatory remark, that "his influence will long be felt in the writings of his pupils and successors."

Studies in Economics. By William Smart, M.A., LL.D. Pp. 341. (London: Macmillan and Co., 1895.)

DR. SMART is favourably known in the economic world by his admirable translations of the writings of the Austrian school; and in these "Studies" the characteristic doctrines of that school furnish no small part of the theoretic apparatus. The exclusive emphasis laid on that side of the theory of value, the elaboration of which is connected in this country chiefly with the name of Jevons—the side of demand, that is, with its controlling factor of marginal utility—is faithfully reproduced by Dr. Smart; and, like the teachers, whose disciple he frankly acknowledges himself to be, he is disposed to treat as "secondary" and "derivative" that influence of cost of production as governing supply, and, through supply, determining value, to which the older English economists, such as Ricardo and Mill, assigned predominant stress. He describes the Austrian theory as the "current" and "dominant" theory; and, while he sometimes accords a hesitating recognition to conceptions which seem to conflict with this exclusive emphasis, his attitude even here appears to be in reality one of doubtful acceptance rather than hearty concurrence. To the writer of this review the later, like the older emphasis, seems mistaken; and the comprehensive attitude of Prof. Marshall, who treats the two sides of supply and demand as mutually determining, appears to be more closely in accord with the facts; and in this impression he is strengthened by the difficulties encountered by Dr. Smart in some of these "Studies" from an unwillingness to allow to cost of production a coordinate influence with that of marginal utility in determining value. On Prof. Marshall's hypothesis the facts seem to fall naturally into their place, but by the Austrians and by Dr. Smart they appear to be forced artificially into a strained position. To this theoretic equipment Dr. Smart has added the valuable qualification of a first-hand acquaintance with the facts of business life; and the advantage of this intimate knowledge is evident in many parts of his book. It consists of three main sections, one devoted to studies in wages, the second to studies in currency, and the third to studies in consumption. Of these the first seems to us the most valuable; and the reason consists in the fact that Dr. Smart's business experience brings a strong admixture of practical sagacity to bear on such matters of concrete interest as a "living wage," the "sliding scale," and "women's wages." He owns in his preface to a proneness, not unnatural in a business man, to "lose himself in the fallacy of the particular instance"; and we are not sure that he has in the course of these "Studies" always avoided this fallacy. But he never fails to be interesting and suggestive, and he is, with rare exceptions, uniformly lucid; and these are qualities as admirable as they are rare in combination. The economic student and—in a more especial degree—the practical man, will find material for profitable reflection in the careful perusal of these interesting "Studies."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Intensity and Quantity of Sunheat at Different Zones.

THE following figures may interest readers of NATURE. They give the relative summer and winter *intensities* of sunheat for every five degrees of latitude, *i.e.* the sunheat per square foot—and also the relative *total quantities* of heat received at the zones extending from 0°–5°, 5°–15°, &c.

Latitude	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°
Summer Intensity	943	971	997	1016	1026	1030	1026	1016	997	973
Winter Intensity	961	915	866	808	752	694	634	569	498	423

Latitude	50°	55°	60°	65°	70°	75°	80°	85°	90°
Summer Intensity	947	909	868	840	821	806	793	780	766
Winter Intensity	345	269	197	135	79	40	18	5	0

Zone	0-5°	5-15°	15-25°	25-35°	35-45°	45-55°	55-65°	65-75°	75-85°
Summer Heat	478	987	964	886	764	612	434	286	84
Winter Heat	469	857	707	550	331	269	100	27	9

The figures are not guaranteed as accurate to the last place, but that place is included so that the totals may be fairly correct when we take the total sunheat over several zones. Thus we get the summer and winter sunheat up to latitude 30° in the ratio of 30 to 23, while from the cap from 30° to the pole the quantities are 25 to 10, on the same scale. Again the summer and winter proportions from 0°–45° and 45°–90° are 43 to 29 and 12 to 4 respectively.

The proportion of the summer and winter sunheats received by the entire hemisphere is obtained as 55 to 33, the unit being the same as before. That these two are almost exactly in the ratio of Ball's and Weiner's numbers, 63 to 37, may be regarded as a sufficient check on the accuracy of the figures, which were calculated separately. E. P. CULVERWELL.

Trinity College, Dublin, November 25.

The Discovery of the Anti-Toxin of Snake-Poison.

IN reference to the statements contained in Prof. Ray Lankester's letter in your issue of December 12, I have to point out that no claim of priority has ever been advanced by me.

Hitherto my communications have been of the nature of preliminary statements, and in such communications it is neither possible to enter into details of the work done by others on the same subject, nor usual to attempt to do so.

On each occasion in which I have described the results of my experiments, I have briefly referred to all previous workers on the subject, in so far as they were known to me; and, in particular, I have definitely mentioned, or otherwise drawn attention to the circumstance that, before I had been able to do so, M. Calmette had published evidence showing that animals could be immunised against snake-venom, and that the blood-serum of those animals possesses antidotal properties.

At the same time, the work done by me was absolutely independent in its conception. It was originated several years ago, and has been carried out on a plan and with aims which were formed independently of the work of any other experimenter. That part of it which has as yet been described in the published abstracts had for the most part been completed before M. Calmette's paper announcing successful immunisation had come to my knowledge. I have rarely had occasion to consult Pasteur's *Annales*, and thus it happened that M. Calmette's paper was noticed only when the literature of a different and purely bacteriological subject was being collected for me. As to the articles in the *Contemporary Review*, I have not seen them, nor did I know of their existence until they were mentioned by Prof. Lankester. THOMAS R. FRASER.

Edinburgh, December 16.

"Pithecanthropus erectus" and the Evolution of the Human Race.

THE remarkable advance made by biology during the last twenty years in the study of the Tertiary mammalia, must strike even the most casual onlooker. It is not merely that an exact knowledge has been gained of a vast number of extinct forms, but that amongst these has been discovered a profusion of missing links, rendering possible the construction of ancestral trees, or diagrammatic illustrations of the successive stages through which existing animals may have been evolved from a common stock. Some of these "trees" may prove to be mere intellectual weeds, which to-day are, and to-morrow are cast into the oven; but others are of robuster growth, finding a firm support in geology, which has been able in many cases to certainly fix the order in which successive branches of the tree have budded forth. It is to be regretted that geology has not been able to do more than this; could it but succeed in the construction of a scale of past time, what fascinating prospects in the study of evolution would be opened out! The construction of such a scale is beset, however, by grave—possibly insurmountable—difficulties, as will readily appear from the following attempt.

For the present there appears little hope of connecting geological events with such astronomical processes as changes of eccentricity and the precession of the equinoxes, and the only method left for our adoption is that of estimating the maximum thickness of the successive systems of stratified rocks. This, however, is to a great extent vitiated at the outset by the heterogeneous character of these systems; some are wholly or in part marine, some fluviatile; some consist largely of organic, others of mechanical sediment; and it is impossible to reduce their various members to any common term.

As there is no alternative, we proceed to do the best we can with existing materials, and shall now endeavour to obtain some approximate notion of the relative duration of the last three periods in the earth's history, viz. the Pleistocene, Pliocene, and Miocene. The first and most recent of these was probably of longer duration than we are accustomed to suppose. Borings sunk in the deltas of existing rivers have seldom penetrated to the bottom, yet they have indicated a very considerable thickness of deposits; thus, in the case of the Po, a boring near the Casa di Dio, Venice, passed through 572 feet of sediment. Near New Orleans, the delta of the Mississippi was penetrated for 630 feet; while the fluviatile deposits of the Ganges were shown, by a boring near Lucknow, to exceed 1336 feet in thickness. In Alaska, however, as the observations of Russell prove, the Pleistocene attains a far greater thickness than this ("Second Expedition to Mount St. Elias in 1891." U.S. Geol. Survey, Thirteenth Report, part ii. p. 24, 1891–2).

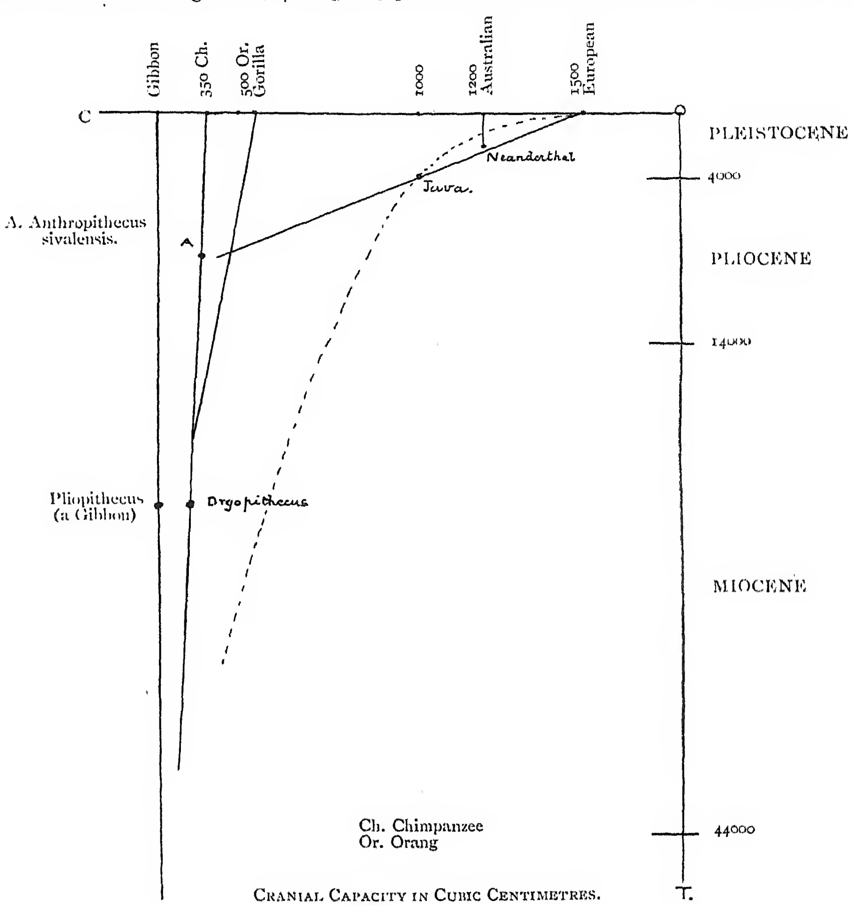
The following extracts from his report may prove generally interesting:—"The Chaix hills are geologically unique. They are formed of a monoclinal block of conformable strata eight or ten miles long, trending north-east and south-west, and tilted northward at an angle of 10° or 15°. . . . But what makes the hills especially interesting to the geologist is the fact that they are composed of stratified morainal material. . . . From many eye estimates it is evident that the minimum thickness of the deposit cannot be less than 4000 or 5000 feet. The rocks are essentially homogeneous from base to summit, and are composed of sandy clay containing large quantities of both angular and rounded boulders of all sizes up to six or eight feet in diameter. In the finer portions of the deposit . . . sea-shells are numerous. A small collection was made. . . . All [the species] are still living in the adjacent ocean. Besides the shells of molluscs, there are the shell-cases of annelids [*Serpula?*] attached to glaciated boulders, showing that the stones on which they grew must have remained exposed at the bottom of the sea for some time before being wholly buried."

It may be objected that these deposits differ so completely from those of the alluvial plain of the Ganges, in their nature and origin, that they might fairly be left out of account; but to this it may be replied that we have no reason for supposing that glacial denudation proceeds at a greater rate than fluviatile, indeed the reverse is probably nearer the truth, and though it is deposition and not denudation which is directly in question, yet the observation of Mr. Russell, that annelid tubes are found adhering to the embedded boulders of the deposit, certainly does not suggest an excessively rapid rate of accumulation. We shall take then 4000 feet as representing the maximum thickness of the Pleistocene system.

In a recent communication (NATURE, vol. li. p. 533) on the age of the earth, I gave 2000 feet as the maximum thickness of the Pliocene system, and this is the thickness which it attains in Europe (Sicily); but in India this is far surpassed, the Siwalik Hills, which are 14,000 or 15,000 feet in height, present for examination at least 10,000 feet of Pliocene deposits.

In Europe the Miocene does not exceed 6000 feet in thickness; but it may be regarded as quite certain that the duration of Miocene time was much greater than that of the Pliocene, and since in Europe the thickness of these two systems is as 3 : 1, we shall probably arrive at a just result if we take three times the thickness of the Pliocene of India to represent, on our scale, the duration of the Miocene period. We thus obtain for the proportional duration of our three periods the relation 0·4 : 1 : 3, which to the geologist has a veridical look.

In order to employ this scale to indicate the rate at which evolution in any particular case has proceeded, we must be able to give a numerical expression to the evolutional change also; and this can be accomplished, at least partially, in the case of the human race. For with it, the organ of organs is not so much the hand as the brain, and of this the volume at least can be ascertained, whenever we can possess ourselves of a human skull. In the following diagram the scale of time is plotted on the ordinate O T to the right, and the cranial capacity on the abscissa O C. The Neanderthal race is assigned to the middle of the Pleistocene, on the evidence of the Spy remains; the Java fossil is placed at the beginning of that period. Dr. Dubois is in possession of evidence which, when fully worked out, will fix its geological position with greater precision than we can attain at present; but so far as his published statements go, they point to that which we have assigned as the most probable horizon. The anthropoid apes are shown on the left of the diagram; the chimpanzee and gorilla are supposed to be the descendants of a chain of ancestors, which converge towards a common stem, on or near which Dryopithecus of the Middle Miocene is situated. This, which we may call the Dryopithecus stem, converges towards Hylobates. It will be observed that we have drawn all these lines of descent sloping towards the left, as they must almost certainly have done if there be any truth in evolution, and consequently the further back we go to find the origin of the human stem, the more brutal we make the primitive ancestor.



If now we draw a line through the point occupied by the average European skull, and that occupied by the Javan skull, we find that it passes very close to the Neanderthal, and this suggests that the evolution of the human race has proceeded at a very uniform rate throughout the whole of Pleistocene time, while the excessive slope of the curve suggests that this rate was a very rapid one. If further we produce this line to the left, it will be found to intersect the ancestral stems of the highest anthropoid apes in the middle of the Pliocene period, and it is to this period that *Anthropithecus sivalensis* of Lydekker, a chimpanzee having affinities with man and Hylobates, has been assigned. The exact horizon from which the palate, on which this species is founded, was obtained is not known; and in this connection one is constrained to express the great regret that all biologists must feel at the imperfect manner in which the Siwalik strata have been investigated. Beds said to be unfossiliferous are known to possess fossils, and of those specimens which have been obtained from the series specially distinguished as fossiliferous, the proper geological position is not known. The Siwalik beds, if carefully searched, might be expected, from what we already know, to yield results no less precious to science than those obtained by Marsh and Cope in the famous deposits of the Green River Basin. It might be well worth considering whether an expedition could not be despatched from Europe for the special study of the Siwalik sediments.

The suggestion offered by the curve running through the apes to man is that he is of comparatively recent origin, and derivative from the stem of the gorilla or chimpanzee before these species had acquired their existing specialised characters. The straightness of the curve has an aspect almost miraculous, not a discommendation to the minds of some; but it has this positive advantage, that by linking on the human to the pithecoid stem at a high level, it saves us from the invention of a superfluity of imaginary predecessors, and all that tends to parsimony in this direction is an evident gain. The evolution along a line of descent is not confined to the acquisition of new characters, but includes the loss of others; and thus I can see no reason why the human ancestry should not have proceeded from the comparatively highly organised ancestors of the gorilla or chimpanzee, rather than from the more primitive predecessors of Hylobates. To those who think otherwise the curve shown by dotted lines will appear the more plausible; if the Neanderthal skull be lifted a little upwards in the scale of time, a curve can be made to pass through it, the European and Javan skulls, and this when prolonged downwards will approximate to the stem either of Pliopithecus (a Miocene gibbon) or the more brutal Dryopithecus. This would be a curve indicating greatly accelerated development as it approaches modern times; a contingency which a preliminary examination of other groups shows to be by no means impossible. Other curves no doubt could be drawn according to fancy of the individual; the true curve may possibly reward some fortunate investigator of the Siwalik Hills.

W. J. SOLLAS.

Globular Lightning.

A GREAT deal has been written recently on the various forms of lightning, and the subject itself has so much scientific interest, that it may be worth while to place on record an observation of my own on globular lightning, made years ago, in which the main facts are different from any I have seen described.

On Tuesday, July 23, 1878, I was on board a large yacht at anchor in the harbour of Southampton, England. About two o'clock in the afternoon, when we were about to sail, a violent thunderstorm came up from the west, and as it passed over Southampton, several bolts descended, one of which, as I afterwards learned, struck a church. As the first drops of rain came down on the yacht, I was standing in the after-companion-way, looking forward, when my attention was attracted by a bright light apparently near the upper part of the foremast. When I first saw it distinctly, it was about half-mast high, and was falling slowly and directly toward the deck. This light was a ball of fire, a delicate rose-pink in colour, pear-shaped in form, with the large end below, and appeared to be four or five inches in diameter and six or eight inches in length.

When it struck the deck, about forty feet from where I was standing, there was a loud explosion, and it was some minutes before it could be ascertained what damage had resulted. The mate, who stood near the mainmast, about twenty-five feet from where I was, was knocked down, but soon recovered. The same bolt, or part of it, also passed in front of the foremast, down a windsail ventilator, into the galley, where it knocked a large tin pan from the hands of a cook, and upset things generally throughout the culinary department, but injured no one seriously. Of the crew, some were on deck, and others below, but none were really injured, although a few were badly demoralised. A strong ozone-like odour was observed immediately after the explosion, and this remained perceptible for some time.

The officer in charge of the yacht, Captain Matthews, who was forward at the time, and escaped without injury, stated that just after the stroke, he saw "streaks of lightning running around on deck like snakes." I was myself only dazed for a moment by the explosion, and saw distinctly that the deck forward was illuminated with a bright confused light. The owner of the yacht, George Peabody Russell, and his other guests, had gone below when the storm began, and suffered no injury, except possibly from fright, as they were still further away from the stroke.

As soon as the storm had passed, I made careful notes of the whole occurrence, with drawings and measurements, as I was much interested in the subject, and it was the first instance of the kind I had seen at close quarters. An inspection showed that the vessel itself had sustained no material damage, and there were not even permanent marks left on the deck where the ball of fire exploded. A number of other yachts were at anchor quite near our vessel at the time, among them the white *Sunbeam*, just home from her well-known voyage, but we saw no indications that any of these had been struck. I had no time to inquire, as immediately after the storm we sailed on a cruise to the eastward.

O. C. MARSH.

Yale University, New Haven, Connecticut, December 4.

Large Human Femora in the Church of S. Eustachius, Tavistock.

TAVISTOCK ABBEY was founded A.D. 961 by Orgar, Earl of Devonshire, and endowed and completed by his son Ordulf A.D. 981. Some bones, said to have been found in an ancient stone coffin in the Abbey ruins, are locally believed to have once formed part of the skeleton of the said Ordulf, a reputed giant. According to William of Malmesbury, this Ordulf could stride across a stream ten feet wide, and he is said, by the same authority, to have torn off the bars from the town gate of Exeter with his hands, and to have wrenched away the hinges with his feet.

The relics, which are preserved under glass in Tavistock parish church, consist of three thigh bones which originally belonged to three different individuals.

Whilst at Tavistock recently I had an opportunity of measuring these bones: the extreme length of one is 1 ft. $9\frac{1}{8}$ in., the second 1 ft. $8\frac{5}{8}$ in., and the third 1 ft. $5\frac{1}{4}$ in. The heights of the original owners were therefore 6 ft. $8\frac{1}{2}$ in., 6 ft. $5\frac{1}{2}$ in., and 5 ft. $5\frac{1}{4}$ in. The two larger bones appear to have belonged to strong well-developed men, the other bone is more delicate.

Dunstable. WORTHINGTON G. SMITH.

A Lecture Experiment in Surface Tension.

WISHING to demonstrate to a fairly large audience the well-known disastrous results of attempting to remove grease stains by placing ether or benzol *on* them, instead of *round* them, and then spirally approaching their centres, I hit on the following plan, which gives not only unmistakable but beautiful results.

A circle of paraffin or olive oil is painted on the centre of a filter-paper, which is then dusted over with bone-black. A light blast of air on the paper removes the bone-black from all portions of the paper except the oiled portion, which looms up jet-black on a pale grey ground. The filter-paper is then folded in four wings, so that its edge forms a curved cross, and it is secured in this position by a penholder which has two longitudinal slits cut at right-angles. (This method of folding and securing will be familiar to all who can recall their school-days to the minutiæ of "penholder darts.")

The tip of the oiled apex of the filter-paper is dipped for a moment or two in ether. The paper is then unfolded, dried, and subjected to a second treatment with bone-black, when it will be found that the ether has chased the oil from the apex, and spread it towards the circumference of the paper in a symmetrical pattern.

It is scarcely necessary to add that there is no virtue in the special method of folding described above, and that a great diversity of beautiful patterns may be obtained by folding the filter-paper, and distributing the oil in other ways.

The Leys School, Cambridge. DOUGLAS CARNEGIE.

An Examination Question in Physics.

IN the subject of Experimental Physics, B.Sc. Examination for Honours of the University of London (December 5), the fifth question of the second paper stands as follows :—

"A plate of uniaxal crystal, cut with the faces *parallel* to the axis, is placed between a polariser and an analyser. How would you arrange a source of light and lenses to show a system of *rings* on a screen?

"Explain how the rings are formed when the polariser and analyser are crossed and the *axis is in the plane* of polarisation of the incident light." (The italics are my own.)

As the B.Sc. Honours is the highest examination of the University, the questions set therein are naturally regarded by students as important tests of knowledge; and I think it would, therefore, be of considerable scientific interest if the examiners would kindly state their intention in setting this question, and the nature of the answer they expected to receive.

Queen's College, Harley Street, W. E. F. HERROUN.

"Linotænia maritima" (Leach).

WILL you kindly allow me to put on record a new locality for this marine centipede?—Bexhill, just above high-water mark. The single specimen taken was kindly identified for me by Mr. R. I. Pocock, of the British Museum (Natural History).

HENRY SCHERREN.

9 Cavendish Road, Harringay, N.

THE TRANSFORMATIONS OF INSECTS.

SO much special work has been done during the last thirty years upon the transformations of insects, that I lately resolved to spend some time in reviewing the most important facts which have been ascertained respecting the structural changes which take place before or during pupation. I had not gone far before I found it necessary to clear up my own thoughts as to the nature of insect metamorphosis, and the way in which it had come about. Some preliminary considerations upon these points, inferred from facts which have long been known, I now propose to discuss, leaving the more special facts to some future occasion.

Three naturalists, Fritz Müller (1864),[1] Friedrich Brauer (1869),[2] and Sir John Lubbock (1874),[3] have in

1 "Facts for Darwin" (Für Darwin).
2 *Verh. Zool. bot. Ges. Wien* (1869). Of less importance is Part 2 (1878).
3 "Origin and Metamorphoses of Insects." (Appeared originally in NATURE, 1873).

our own time written upon the origin of insect transformations. It was, as they themselves tell us, Darwin's "Origin of Species" which incited each of them to look at the old facts in the light of a new theory. Fritz Müller, being at the moment specially occupied, not with insects, but with crustaceans, threw out casually, as it were, a number of general results of the greatest interest and value, which he did not attempt to support nearly so fully as his own knowledge of insects would have enabled him to do. Brauer, a little later, travelled over the subject in a somewhat more leisurely way. The most important principles had already been indicated by Müller, but he was able to contribute many facts of special interest, and to point out a definite and rather widely distributed larval stage, of which much has since been said in discussions on the phylogeny of insects. I need not remind English naturalists that, even before 1874, Sir John Lubbock had won fame by his researches into the life-history and habits of insects. He had also written specially upon insect transformations before he collected his matured thoughts into a book. His "Origin and Metamorphoses of Insects" is now very widely known. It is by far the most readable exposition which we possess, and will long hold its place as an interesting account in simple language of that part of the subject which involves no special knowledge of insect anatomy. Some day it should be supplemented by an account of the mechanism of pupation, showing in detail how various larvæ are converted into winged insects. It is on this side that insect transformations have been most successfully attacked during the last thirty years.

It is natural that after an interval of many years we should find what seem to be deficiencies in the work of those who have gone before us. The most notable deficiency which I find in Lubbock's book is that he does not remark the great distinction between insect metamorphoses and those of most other animals.[1] They occur, as I think, in a different part of the life-history, and arise out of conditions which are different, or even diametrically opposite. There are other points, too, which seem to me to be passed over too briefly by Lubbock and all previous writers. In particular, certain aphorisms of Fritz Müller seem to me to deserve a fuller explanation than they have yet received.

Such inevitable gaps in the expositions of our predecessors render it possible to supplement even works which have attained the rank of classics. Each generation for a long time to come will be able to add its quota of facts and reflections without exhausting this immense and difficult subject of inquiry. It is satisfactory to note that Lubbock's account has been very little disturbed as to matters of fact by later investigations, so that his readers, though they have plenty still to learn, have very little to unlearn.

Let me first attempt to justify my contention that the transformations of insects are fundamentally unlike the transformations of polyps, echinoderms, mollusks and crustaceans. In the marine groups the minute animal, just escaped from the egg, passes rapidly through its changes, often before the yolk is absorbed. It may complete them before it begins to feed, always long before it has attained its full size. The insect, on the contrary, undergoes its most striking change of form after it has attained its full size. Moreover, the planula of the polyp, the bipinnaria or pluteus of the echinoderm, the Nauplius or Zoæa of the crustacean, are unknown except as transitory forms. But the less specialised insect-larvæ make a very close approach to certain lower, wingless insects in their adult state. The insect-larva, before it gives place to the pupa, has not only attained its full size, and acquired a form answerable to that of some perfectly adult insects, but it already contains in many cases completely developed reproductive products; indeed, a very few insects are known to be capable of reproduction as larvæ. It seems to me preposterous to say, as Harvey did in the 17th century, that the insect-larva is a kind of walking egg, or with Quatrefages, that it is an embryo which leads an independent life. It would be far more truthfully described as an animal which has attained the normal structure of adult Arthropods, though it has still to undergo a peculiar adult transformation. Where the insect larva falls short of that adult structure, it is because abundance of food, or some other external circumstance, has induced degeneration, but we shall best understand insect-larvæ in general by comparing them to sexually mature myriopods, protracheates, scorpions and Thysanura.

Adult transformation is rare among free-living animals, though parasites furnish many examples. The Ctenophora, instead of settling down early, maintain a pelagic life, and became specially modified thereto in a late stage of development. The secondary sexual characters assumed by some birds and mammals at the time of sexual maturity, such as the train of the peacock, or the antlers of the stag, are analogous facts. But the closest parallel to the transformation of insects is to be found in the Amphibia. Frogs and toads, having already as tadpoles attained the full development of the more primitive Amphibia, change to lung-breathing, tailless, land-traversing animals. The motive is the same as that which led to the acquisition of wings by insects. It is by virtue of their adult transformation, that both the amphibian and the insect are enabled to wander from the place of their birth, to seek out mates belonging to other families, and to lay their eggs in new sites.

In those Amphibia which undergo transformation, the stage added to the life-history of the more primitive forms is not the tadpole, but the frog or toad. In those insects which undergo transformation, complete or incomplete, the winged state is the new addition. If a pupa appears in the life-history, it results indirectly from the acquisition of wings by the adult. Hence it seems to me that in Amphibia and insects the peculiar change, which renders possible all the rest, belongs to the adult condition, *i.e.* these animals undergo an *adult* metamorphosis.

Transformation in the inhabitants of the shallow seas is closely related to the crowded state and severe competition of the area. The connection is two-fold. Unusual risks imply numerous eggs, numerous eggs must be small, and small eggs, with little or no yolk, hatch early, producing very immature animals, unlike their parents. Again the risks of the shore favour heavy-armoured species, and it is well-known that a great proportion of the invertebrate fauna of the sea-shore is defended in this way. But heavy armour diminishes activity, and in particular often renders swimming impossible. The dispersal of the species is therefore left to the young fry, which are often specially organised for locomotion at the surface of the sea. Marine animals which are not armoured, such as the Cephalopoda, may undergo no transformation at all.

Certain general propositions concerning larval transformation are disturbed if the adult transformation of insects and Amphibia is included. Indeed, I was first led to notice the distinction between adult and larval transformation by observing that insects and Amphibia do not conform to the general rule, that while the inhabitants of the shallow seas go through transformations in early life, fluviatile and terrestrial animals do not.

Every animal and every plant has these two functions

[1] I am not aware that any one else has made more than a passing allusion to this distinction, but I may easily have overlooked some important reference in the vast literature on insect transformations. Macleay has remarked that in insects the change of form takes place during their last two or three stages, whereas "the metamorphosis of all other Annulosa only occurs during the first or second moult after leaving the egg." (*Illustr. Zool. South Africa*, p. 53). I do not find this distinction recognised as part of ordinary biological knowledge in our best treatises on development, such as Balfour, or, Korschelt and Heider.

(among others) to fulfil. It must feed and grow; it must also separate from its fellows, and find out an unoccupied site. The two functions may be discharged together. Birds, for instance, feed all round the year, and change their abode whenever they suffer from overcrowding or scarcity of food. In other cases, either function may for special reasons be limited to a particular time of life. The crustacean cannot migrate effectively when adult, because of the heavy armour which it carries. The insect cannot migrate effectively when young, because of the difficulty of travel by land. It is easy for a minute animal to travel by sea. The high specific gravity of the water renders the body buoyant, and currents, even where special locomotive organs are absent, will do the work of transport. Power to rise and sink in the water is convenient, but even this is not strictly indispensable. On land the conditions are very different. The weight of the body has to be supported in a comparatively rare medium, and much greater exertion is called for Running, leaping, and flying are difficult exercises, much better performed by the adult than by the larva, if these should happen to differ materially.

It is often of advantage that there should be division of labour between the several stages of the life-history, and the functions of migration and growth may be allotted to special times of life instead of being carried on throughout. Migration is naturally associated with lightness and activity; feeding and rapid growth are favoured by a sedentary habit. If such division of labour should take place, as it commonly does in crustaceans and insects, the crustacean will find it convenient to perform its migration early, when it has little armour to carry, and when its surface is large in proportion to its weight. The Zoœa will do little more by its own exertions than maintain the right attitude and the right distance from the surface of the sea, leaving the currents to effect the actual transport from place to place. Migration over, it will settle to the bottom, acquire heavy armour as a defence from its many enemies, and begin to feed in earnest, becoming in the end a slow and heavy inhabitant of the sea-bottom. With the insect the procedure will be reversed. Being unable to travel far while small and weak, it will feed first, and having attained its full size, will then, if at all, acquire special means of locomotion. Wings are more efficient as a means of transport than any other organs of locomotion of which a terrestrial animal can avail itself; but flight is so difficult an exercise that wings, if acquired at all, will be acquired late.

Marine animals commonly produce far more eggs than insects.[1] The risks of the shallow seas are so great that a small proportion only of the young animals comes to maturity. Hence the enormous fertility of common marine animals, except such as are able to nourish or defend their young. Where a vast multitude of eggs hatch out together, dispersal in search of food becomes an immediate necessity.

The more sluggish and sedentary the adult, the greater the activity we may expect to find in the larvæ. It is they which have to travel and to find out suitable quarters. But they often make up by their numbers for any deficiency in enterprise or intelligence. Vast numbers of Zoœas are swept into mid-ocean or into tidal rivers, or are devoured. It is only a chance remnant that survives.

Just as the sluggishness of the adult crustacean or echinoderm may promote activity in the young, so the activity of the adult insect may discourage activity in the young. The power of flight possessed by most adult insects favours a sedentary life in the larva, which is spared all effort in connection with the dispersal of the species, and can give its undivided attention to feeding. Accordingly the larva often degenerates more or less, especially when its food is abundant and obtained without labour or risk. The sagacity and industry of the bee in storing its cells with honey may be said to have cost the larva its legs. So, too, the active and highly-gifted blow-fly, ichneumon, and gall-fly secure abundant food for the new generations, which emerge as footless grubs. In the Coleoptera we find that the larvæ, which feed on dead vegetable matter beneath the surface of the ground, are heavy-bodied and short-legged, sometimes so overloaded by the weight of the abdomen that they rest lying on one side. The larvæ of weevils, which are vegetable-feeders and often buried in the plant which they devour, are commonly without legs altogether. Even the head of the larva may be reduced almost to nothing by the labours of the adult insect. The blowfly finds out a practically inexhaustible supply of carrion in which to lay its eggs, and the larval head is so reduced that it consists mainly of a pair of large hooks, with muscles to work them, and a chitinous frame to form a fulcrum for the muscles.

The degeneration of the larva can only proceed far when the adult undertakes the dispersal of the species. That is why, it seems to me, the larvæ of marine animals, though often very unlike their parents, are not really to be called degenerate. They cannot be supposed to have arisen from ordinary forms, typical of the class, by mere disuse and reduction of the organs of active life. On the contrary, they are often immature forms specialised for locomotion.

Even when the adult undertakes the dispersal of the species, the larva does not necessarily become degenerate. The winged locust is the chief agent in dispersal, but the larvæ are active, seek their own food, and exhibit no marks of degeneration. It is only when their choice and responsibility are taken away, when they are encouraged to feed almost without intermission, or to bury themselves out of sight, that they degenerate.

Parental care and all labours undertaken by the parent for the sake of the offspring tend to promote helplessness in the young. The helplessness of the higher Vertebrates at birth, as well as their prolonged fœtal development, are due to the fact that their parents are able to find them food and protection. Here there is no degeneration in the young; though helpless, they are of the same zoological grade as their parents. The locomotive organs and the senses of a baby or a nestling bird are as complex as those of the adult, and are merely feeble for want of skill and exercise. In the larval insect there may be real degeneration, fewer limbs, fewer joints in the limbs, deficiency of sense-organs, relative preponderance of the organs of nutrition. If the transformation of insects had never been traced, the structure of the two stages would have inevitably led zoologists to place the caterpillar in a lower class or order than the butterfly.

There has been much speculation as to the form of primitive insects. Fritz Müller supposes that the wingless Orthoptera come near to the original stock, while others have derived all insects from the wingless and non-metamorphic Thysanura. By taking what is common to the least modified Orthoptera and the Thysanura, and rejecting all features peculiar to either, we shall certainly get a highly generalised insect, such as might possibly be a common ancestor for the whole group. Brauer pointed out that such primitive insects still survive in Campodea and Japyx, which have mouth-parts (as Lubbock considers) "intermediate between the mandibulate and haustellate types," one pair of many-jointed antennæ, three pairs of long legs, and an abdomen whose first seven segments bear pairs of rudimentary appendages, while the tenth and last segment bears in Campodea a pair of many-jointed appendages, in Japyx

[1] No statistics have been collected to my knowledge on an extensive scale. Very many insects lay their eggs singly. In particular cases (social insects, Meloidæ, &c.), where special reasons obtain, they may be laid in great numbers, but my general impression is that the eggs of Echinoderms or marine Crustaceans would be far more numerous as a rule.

a forceps. Campodea and Japyx have no eyes, but this is not considered typical; simple eyes are usual in insects of the same grade. They undergo no metamorphosis.

Brauer finds forms closely resembling Campodea among the larvæ of Orthoptera, Perlidæ, Odonata, Ephemeridæ, Coleoptera and Neuroptera. In Strepsiptera and Coccidæ he considers that they are present in a more modified form. No Campodeiform larvæ occur among Lepidoptera, Hymenoptera, or Diptera.

Brauer looks upon the caterpillar of Lepidoptera, Sawflies and Panorpa as a degenerate Campodea, while he considers the apodous maggot of many Coleoptera, some Neuroptera, Bees and Muscidæ as a still more degenerate larva, derived from, and not historically antecedent to, the Campodea. Grassi and others have brought forward facts to show that the maggot-like Bee-larva has previously passed through a kind of Campodea-stage.

Lubbock regards the caterpillar too as essentially a Campodea. But this extension seems to me to take all definiteness out of the Campodea-form. If every larva with biting mouth-parts and six legs is to be called a Campodea, we still want a name for the larva which has long legs, long antennæ and at least one pair of abdominal appendages.

Brauer's Campodea seems to invite comparison with Scolopendrella and Peripatus; just as the more generalised Campodea of Lubbock invites comparison with the hexapod larva of Diplopoda and Atax. I do not venture to pursue these comparisons, which involve difficulties not apparent at first sight, and will only remark that the former comparison seems to throw most light upon the phylogeny. The leg-bearing segments of the Diplopoda are apparently not the same as those of insects, and the embryology of insects points to a polypod, rather than to a hexapod, as the common ancestor of the Tracheates.

If it seems rash, with our present knowledge, to trace the phylogeny of Peripatus, the Myriopods and the insects, what shall we say of Lubbock's far bolder attempt to derive his Campodeiform larva from a Rotifer-like ancestor? It is suggested, though not positively asserted, that certain apodous dipterous larvæ exemplify this earlier stage. I must declare myself altogether sceptical as to a Lindia-stage antecedent to the Campodea. The only apodous insect-larvæ known to me are born of highly specialised insects, and have apparently become degenerate in consequence of the completeness of the provision made for them by the intelligence or special instincts of the parent. They are, as Brauer humorously says, like the sluggards in Hans Sachs' Lubberland, who required roast pigeons to fly into their mouths. I see in them no mark of a primitive insect.

Brauer in 1869 was ready to derive the maggot from the caterpillar, and the caterpillar from the Campodea (p. 310). He points out, very truly, that the reduction of the larval head of the Diptera may be gradually traced from forms in which it is perfectly developed. It is a pity that he did not bear his own explanation in mind when at a later date he attempted to arrange the Diptera Nemocera by characters largely drawn from the degree of development of the larval head. The unsatisfactory nature of the result has been pointed out by Baron Osten Sacken (*Berl. Ent. Zeits.*, Bd. xxxvii. p. 417, 1892).

That Brauer's arrangement of the Nemocera does not, in the opinion of experts, associate allied forms, shows that he has been unfortunate in his use of larval characters. Could that result have been anticipated? Is there any general objection to the employment of larval characters in the definition of large groups of insects? I think that there is. In his paper of 1869 Brauer, following Fritz Müller, remarks that the development of various insects has been either abbreviated or falsified. He thinks that the Hemiptera have lost a transformation which they once possessed. He thinks that Dipterous larvæ and others have been acted upon by conditions of life which have not affected the imago. Yet he has employed characters which he knew to be highly adaptive and also finely gradated, for the definition of his tribes and families. Brauer is both a systematist and a philosopher, but his system forgets his philosophy.

Primitive insects, we may suppose, attained the Campodea form in the egg, after which they merely increased in size without important modification of structure. The next step opened the way to extraordinary developments, which were not, however, immediate or necessary consequences. Certain insects acquired wings as adults, while others remained wingless and pursued the old life. The acquisition of wings did not as a matter of course greatly affect the habits of the species. Some, like the grasshoppers, crickets, and cockroaches of to-day, continued to run about on their long legs in all stages, and divided their food with the same kind of jaws as their wingless progenitors. But when full advantage was taken of the new means of locomotion, the life-history was profoundly affected, the two extremes, early and late, being acted upon in opposite ways. The imago grew more active and quicker to discover the best sites for egg-laying, gradually undertaking the whole function of dispersal of the species. The larva, thus relieved from choice and travel, became slow and clumsy, escaping its enemies by protective resemblance or burrowing. It came to be more and more exclusively occupied with feeding, while the adult, except where the business of egg-laying was unusually protracted, fed less and less, sometimes not at all.

The quiescent pupal stage seems to me to have arisen from the contrast between the degenerate, slow, voracious larva and the active, highly organised and sensitive imago. Sagacity and activity gradually declined in the larva, and became exalted in the imago, until the extremes of the life-history became so unlike that they could only be reconciled by profound changes, incompatible with locomotion and feeding.

I quite agree with Lubbock's remark, "that the apparent abruptness of the changes which insects undergo, arises in great measure from the hardness of their skin, which admits of no gradual alteration of form, and which is itself necessary in order to afford sufficient support to the muscles." The hardness of the skin in insects and other Arthropods involves periodical moults in order that the body may increase in size. Pupation is an exaggeration of one of these moults, the subsequent escape of the imago is an exaggeration of another. These two moults are the last but one, and the last of all, and the pupal stage, where there is one, intervenes between them.[1] An ordinary moult gives opportunity for effecting slight changes in the chitinous cuticle. The new skin is not necessarily moulded precisely upon the old one. If increase of size is required, the new skin can be made a little larger, and accommodated within the old one by wrinkling or folding. It is in this way that the wings of an Ephemera, a dragon-fly, or a male cockroach gradually attain their full size. If projections of unusual length are to be formed beneath the old skin, they can easily be telescoped into the body; a process which attains a high degree of complexity in some insects.

Many insect transformations, too familiar to be detailed here, illustrate the great facilities afforded by the change of skin for replacement of organs lost by degeneration, or for development of new ones, more elaborate than any possessed by primitive insects. But for these facilities I imagine that larval degeneration would never have gone so far as it has done in insects; the price to be paid would have been too heavy.

[1] It has come to pass, by some process which I cannot trace, that in Ephemeridæ, where there is no pupal stage, the fly quits the water at the last moult but one, and immediately afterwards casts another very thin skin.

How insects first acquired wings, and from what structure they were derived, is still a profound mystery. A favourite conjecture is that they arose by the modification of tracheal gills. In favour of that supposition is the fact that in some dipterous larvæ (Chironomus, Simulium, Culex, Muscidæ), three pairs of rudiments (imaginal folds) form on the dorsal surface of the thoracic segments, and as many on the ventral surface. The ventral rudiments ultimately become the legs of the fly. Of the dorsal rudiments the second becomes a wing, the third a rudimentary wing, and the first the respiratory organ of the pupa, which may take the form of a trumpet or a bunch of branching tubes. In the larvæ of the Muscidæ this anterior dorsal appendage is said by Weismann to form much later than the rest, only during the last larval stage, and to be greatly inferior in size. In Chironomus and Simulium it forms at the same time, and is quite similar to them. Where an anterior spiracle exists, as in the Muscidæ, the anterior dorsal appendage forms close behind it, and ultimately replaces it. Now, if it could be clearly shown that all three dorsal appendages form one series, and that one or two are converted into wings, while the foremost becomes a breathing-organ, we should at least know that a wing and a breathing-organ may have a common origin. So much seems probable, but we must still wait for conclusive facts before we can explain how insects first got their wings.

In many Orthoptera, and other hemimetabolic insects, effective wings are developed without any resting-stage. I think that we may safely infer that historically wings were acquired before complete metamorphosis set in, and before insect-larvæ underwent degeneration.

Though the fact must, of course, be well known, I do not remember that any zoologist has expressly mentioned that the resting-stage of insects is unique among animals. The nearest phenomenon of the same kind is the encystment of certain Protozoa and parasites; but cessation of all the functions of active life, when these have once been assumed, for the purpose of effecting a definite advance in organisation, is a thing peculiar to insects. Hence we cannot check our interpretations by examples taken from outside the class. But all insects do not pupate, and we may learn something by studying the hemimetabolic insects in which there is no quiescent pupa.

Nearly all these insects (some few Orthoptera and some Rhynchota are exceptions) ultimately acquire wings, the rudiments of which may be externally visible long before the imago stage is reached. In hemimetabolic insects it is unusual to find any marked change in the food, the mouth-parts, the general form of the body, the texture of the skin, the length of the legs, the muscles, or the nervous system. It is often difficult to distinguish a full-sized larva from the imago without close examination. In Ephemeridæ, Perlidæ, and Odonata the larva is aquatic and the imago aërial, so that notable changes appear in the mode of respiration, but still the transition is effected without a resting-stage.

We have seen that wings may be acquired by insects which pass through no pupa-stage. There is, however, hardly a case (the parasitic flea is one) of an insect which pupates without acquiring at least the rudiments of wings in one or other sex. The main purpose of pupation would in general be defeated if the adult were wingless.

Change in the form of the mouth-parts, if so considerable as to involve a new method of feeding, *e.g.* the substitution of sucking for biting, cannot be effected without a quiescent pupa-stage. It seems inevitably to involve a rather prolonged interval during which the old mouth-parts are not in working order, while the new ones are not yet complete. But though considerable changes in the mouth-parts imply a quiescent pupa, they are not the sole reason for pupation. The larva and imago of many Hymenoptera and Coleoptera have similar mouth-parts, yet they all pupate. Neither acquisition of wings nor great changes in the mouth-parts can be the sole reason for pupation, for pupation is not indispensable to acquisition of wings, and it is not always followed by material changes in the mouth-parts.

Lubbock quotes from his earlier memoir on Chloeon (*Linn. Trans.*, vol. xxv. p. 486, 1865), the remark "that the occurrence of metamorphoses arises from the immaturity of the condition in which some animals leave the egg." Insects are specially referred to, for in the memoir quoted we are told that the necessity for change depends on the fact that most insects leave the egg in a very early condition, and that this again is probably owing to the fact that the amount of nourishment in the egg is insufficient to carry the insect to maturity. Brauer adds that the eggs of insects with complete metamorphosis are regularly smaller in proportion to the parent than those with incomplete metamorphosis or none.

I believe that Lubbock's explanation is true of many marine invertebrates, but not of insects. The vast number of eggs laid by a crab or a sea-urchin is very likely one cause of the smallness of the eggs and of the unlikeness of the larva to the parent. The transformation which assimilates the larva to the parent is in such cases effected as soon as possible after the migatory larva has settled down and begun to feed. But in the insect there is, as a rule, no important advance in structure during almost the whole of the larval period. If deficiency of nourishment had occasioned a temporary arrest of development, abundance of nourishment would surely have made up the loss sooner. The time of pupation seems to me too distant from the time of hatching, especially as the whole period of active feeding and rapid growth intervenes, to be entirely due to the conditions of nourishment of the larva in the egg. Special facts, of which many could be cited, tell against Lubbock's explanation. The Staphylinidæ commonly lay relatively large eggs, and yet undergo complete metamorphosis. Some insects actually retrograde before hatching out, and lose legs which they had already acquired, a pretty clear proof that want of nourishment was not the cause of what is called their immaturity at birth. The state of the insect at hatching seems to me to depend far more upon the conditions of larval life than upon the supposed privation of nourishment during embryonic development.

It is plain that insects have gained very much by complete metamorphosis. The extraordinary numbers and range of the holometabolic insects settle that fact decisively. If further proof were required, we might point out that the resting-stage or quiescent pupa seems never to have been lost in any insect which once possessed it. It is hard to prove a negative, but I cannot call to mind a single clear instance. So powerfully has adaptation acted upon insects that almost every organ and almost every stage is known to disappear at times. Wings, legs, eyes, mouth-organs, head, are known to be deficient in the larva, and a very few adult insects have no functional wings, legs, eyes, or mouth-organs. The single order Diptera furnishes us with examples of suppression during the larval stage of all these organs. The egg, the larva, the winged imago may disappear as independent stages in the pupiparous Diptera. But the quiescent pupa remains in every case where it can be shown to have once existed. At most the pupa (in holometabolic orders) becomes in some degree capable of locomotion; it never feeds.

We cannot reckon among the advantages secured by complete metamorphosis the acquisition of wings, for many insects which acquire wings have passed through no resting-stage. Among these hemimetabolic insects are the dragonflies, which take their prey on the wing, but in general the hemimetabolic insects gain nothing by flight, except facilities for dispersal and egg-laying.

The female ant, and apparently the Ornithobia, lay aside their wings as soon as the eggs are fertilised. In adult hemimetabolic insects the mouth-parts are either like those of the larva, or not functional at all; the form of the body, the texture of the cuticle, the organs of sense, and the legs are in general those of the larva, so that we might consider the imago as merely a winged and sexually mature larva.

But the imago of the holometabolic insect is always more than a winged and sexually mature larva. It differs in the form of the body, in the internal anatomy, in the organs of special sense, and usually in the structure of the mouth-parts. Perhaps the smallest advance upon the larva is seen in the imago of the Adephagous Coleoptera, but even here, though the mouth-parts are generally similar and the wings often rudimentary, the difference between the adult and the larva is much greater than in a locust, cricket, or cockroach. Some anatomical comparisons which I have made between the larva and imago of the Carabidæ, point to great changes in the muscular system as sufficient to explain the retention of the resting-stage even in the absence of other motives. The changes in the muscular system are rendered necessary by extensive changes in the shape of almost every segment and every appendage. But the reason of these changes of shape is sometimes hard to discover.

The greatest advantage won by holometabolic insects is access to the pollen and honey of flowers. Both flowers and insects benefit by mutual help, and have become specially modified to make the most of it. Perhaps no ametabolic insect regularly visits flowers. Some small Hemiptera, which are hemimetabolic, do so, but I believe that their visits have not called forth any special adaptation on either side. The Coleoptera, though holometabolic, have biting jaws, and this may be the reason why so few of them regularly haunt flowers. Hermann Müller tells us that some tropical beetles have the maxillæ specially modified for honey-sucking.

Three large orders of highly-organised insects contain a greater or less number of honey-sucking species. These are the Diptera, the Hymenoptera, and the Lepidoptera. The honey-sucking Diptera are comparatively few, but they are of importance to flowers, many of which depend upon their visits for the fertilisation of their ovules. The honey-sucking Hymenoptera are the bees. Of all insects these make the greatest use of honey and pollen, feeding upon it throughout life; they exhibit a more elaborate collecting apparatus, and have acted with more effect upon the organisation of flowers than any other insects. In Lepidoptera honey-sucking becomes more frequent than in any other order. Every moth and butterfly that feeds at all sucks honey, to pass over such unimportant exceptions as the fruit-eating moths with perforating proboscis.

It is a striking proof of the importance of insects in nature that they should have been able to call into existence a profusion of beautiful flowers. All the flowers of the garden and conservatory, all the wild flowers which delight us by their perfume, colour, or form, are in a sense the work of insects. What they found ready to hand was a multitude of green or sober-tinted flowers of small size, without honey or scent; the visits of insects have done all the rest. Flowers have done almost as much for insects as insects have done for flowers. Flowers are to innumerable tribes of insects all that domestic animals and cultivated plants are to mankind. Honey, which may be considered a joint product of the flower and the insect, owes its great importance to three properties. It is fluid, it is highly nutritious, and it can be stored without undergoing putrefaction. Its fluidity and concentration render it particularly suitable as a food for those winged insects which lay their eggs singly or a few together on scattered plants of one kind, and which must, therefore, spend much time in egg-laying, as well as to those which spend much time in excavation or building. Upon the fact that honey can be stored for many months depends the whole domestic economy of many species of bees and ants. The chemical possibility of the conversion of honey into wax was a discovery made by bees to the great advantage of their architecture. Not only have special instincts been founded upon the properties of honey, but its pursuit has led to increased swiftness on the wing, keener perception of colour and distance, as well as to obvious modifications of mouth-parts and stomach.

Like other facilities which encourage activity and intelligence in the adult, honey-sucking tends to arrest the development of the larva. The parent undertakes all responsibility and labour, and leaves the young with nothing to do but to feed and grow.

Honey-sucking is associated, but not rigidly or indispensably, with the highest faculties ever attained by insects. It marks, perhaps, the highest phase in their evolution. No insect can get so high without passing through a quiescent pupal stage, for without metamorphosis it cannot acquire organs of sufficient delicacy. Those which attain to honey-sucking have within their reach all the accomplishments and all the civilisation of which any insect is capable.

To any one who considers the great importance of honey in the life of the higher insects, it is a surprise that ants should have climbed so high without honey-sucking. They have biting jaws, and the workers have no wings. Hence they are useless for the fertilisation of flowers, and many flowers have developed elaborate obstacles for the express purpose of excluding ants. Ants, however, do supply themselves with honey in spite of all obstacles. They will get it from Aphides if no better way can be found. Some ants have learned to store honey in subterranean receptacles, the most singular of which are the enormously dilated crops of certain individuals of the community, which sacrifice themselves for the good of the rest, and are converted into enormous, globular honey-pots. The Myrmecocystus of Mexico, and the Camponotus of Australia, furnish us with examples.[1]

It would seem as if ants had sacrificed their wings for the sake of carrying on their subterranean life with greater ease. They have paid a heavy price for this advantage, for loss of wings in the end involved exclusion from flowers. The bees have managed to keep their wings, and yet to build elaborate structures for the family.

Beginning with the Campodea form, insects have ascended through several degrees of specialisation, acquiring first wings, then complete metamorphosis, and lastly attaining to honey-sucking. They have also descended through equally marked stages, losing length of limb first, then losing their limbs altogether, and in extreme cases losing their heads and jaws almost completely. The highest perfection of the insect-type is always found in the adult, the lowest degeneration in the larva. To the intervention of the resting-stage is due a singular relation between the two processes of evolution and degeneration, which is, as far as I know, peculiar to insects. In insects, as a general rule, the higher the organisation of the adult, the lower the degeneration of the larva. The complete metamorphosis of the Coleoptera, Lepidoptera, Hymenoptera and Diptera has rendered it possible for their larvæ to degenerate, and yet recover in a later stage all that has been lost. The grubs of the weevil and the bee would not have lost their legs if the parent had been unable to provide them with a store of food sufficient for the whole larval period, which could be devoured without leaving the place of hatching. The maggot would not have lost head and

[1] Lubbock, "Ants, Bees, and Wasps," p. 19.

jaws if the fly had been unable to lay its eggs in an abundant supply of highly nutritive food.

The illustrative table will render it easier to realise that in insects as a general rule, special development upwards involves special development downwards in an earlier stage, and also that only a very moderate difference between the extreme forms of the larva and the adult can arise without a resting-stage. Abundance of food, and a life without exertion, often render the larval skin soft and extensible. Since in insects the chitinous

EVOLUTION AND DEGENERATION OF INSECTS.

	Thysanura	Orthoptera	Coleoptera (Adephaga)	,, (Lamellicornia)	,, (Weevils)	Hymenoptera (Saw-flies)	,, (Bees)	Lepidoptera	Diptera (Nemocera)	,, (Muscidæ)	,, (Syrphidæ)
Honey-sucking							·	·			·
Complete metamorphosis			·	·	·	·			·	·	
Wings		·									
Campodea	·	·	·								
Legs reduced				·		·		·	·		
No legs					·		·				
Head reduced										·	·

cuticle furnishes a chief part of all the organs of locomotion, of prehension, and of special sense, a soft, extensible skin involves complete degeneration. This may last throughout the whole larval period, during which the external conditions are usually the same. Then comes the sudden change to a stage in which a maximum of activity and intelligence is called for.

It will be evident to those who have previously studied the subject that Fritz Müller has been my chief guide in this discussion. We owe much both to Brauer and to Lubbock, but I think that we owe to Müller, and indirectly to his master, Charles Darwin, the most considerable advance in the philosophy of transformation that has been made for two centuries.

L. C. MIALL.

LUDWIG RÜTIMEYER.

THIS distinguished naturalist was born at Biglen, in the Canton Bern, in 1825. His father was the parish clergyman, but was shortly afterwards made superintendent of the Orphanage at Bern. Here Ludwig, when old enough, attended the High School, going when sixteen years of age to the Gymnasium. At this time he made the acquaintance of Bernhard Studer, and with him made several excursions to the surrounding Alps. In 1843 he entered the University of Bern, with the intention of following his father's profession, and for some years devoted himself to theological studies; but all the time he seems to have been more or less attracted to the study of natural history, and, as we believe, partly influenced by the companionship of Peter Merian (the well-known palæontologist of Basel, born 1795), Rütimeyer took up the medical faculty about 1848, and for the rest of his life devoted himself to to the study of comparative anatomy. He soon extended his travels, and we find him in 1850 at Paris, where, among many others, he met Elie de Beaumont. In 1851 he visited the south of France and Italy, going as far as Palmero. In 1852 he came to London, and made the acquaintance of Owen and Murchison. Returning to Bern, he published "Vom Meer bis zu den Alpen," the substance of which he had given as a course of popular lectures. He filled the post of teacher in the Technical School, and seems at this period of his life to have had the not unusual struggle in striving to make both ends meet. He married in 1855, and through the influence of Peter Merian he was appointed to the recently-founded chair of Zoology and Comparative Anatomy at Basel, which post he held until his death, which took place on the 26th of last month.

It is not necessary to give a list—it would be long one—of Rütimeyer's published works. He was scarcely settled at Basel before memoir after memoir came from his pen. One of the earliest, laid before the Natural History Society of Basel, was "On Recent and Fossil Swine," showing then the tendency his thoughts were taking. Perhaps the work by which he will be the longest remembered by, will be "Die Fauna der Pfahlbauten in der Schweiz." In this quarto volume we have a careful series of researches into the natural history of the wild and domestic mammals of Middle Europe, which attracted great attention at the time, from the preciseness of its details and the wideness of its speculations. It was published in 1861, a couple of years after the first publication of "The Origin of Species"; but many of the details had been laid before the Society of Antiquaries of Zürich in the previous year, and the author was fortunate in having the assistance of such investigators as Keller, Morlot, Uhlmann, Troyon, and Forel.

Personally Rütimeyer was extremely amiable; he was a good teacher, after what is now being called the old type; minute investigation he never attempted; he left the microscope to others, beginning his life at the parting of the ways, and interested chiefly with the study of fossil forms, he always remained a morphologist.

NOTES.

THE Paris Academy of Sciences has awarded the Lecomte prize of 50,000 francs to Prof. Ramsay and Lord Rayleigh for their discovery of argon.

THE French Chamber of Deputies has unanimously agreed to refer to the Budget Committee a proposal to contribute to the Pasteur statue. The Committee and the Government will decide on the amount.

IN connection with the visit of the British Association to Liverpool in 1896, meetings of the sub-committees have been held under the presidency of Sir W. B. Forwood and Mr. E. K. Muspratt. The principal result is to make some alterations in the places of meeting of the various sections. It had been arranged that the reception and the central offices should be in St. George's Hall. It has now been arranged that the sections of physics, chemistry, zoology, and physiography shall hold their meetings at University College, that the Town Hall shall be placed at the disposal of the economic section, and that St. George's Hall and the Walker Art Gallery shall be devoted to the remaining sections of geology, engineering, anthropology, botany, &c. It was announced that Prof. J. J. Thomson had accepted the presidency of the mathematics and physics section, while Mr. J. E. Marr will preside over the geologists, and Prof. E. B. Poulton, Hope Professor at Oxford, the section of zoology. The local secretaries hope to be able to publish shortly a complete list of those who have accepted nomination as presidents in the remaining sections.

THE benefactions recently showered upon American educational institutions are bewildering in their multiplicity and munificence. Among the latest reported are several tracts of land purchased near the new site of the University of the City of New York in the annexed district of New York City, and intended for the benefit of that university. Mr. Frederick Baker has paid 35,000 dollars for a lot which he intends to devote to the erection of a hall. Several acres have come into the possession of the Dutch Reformed Church, and on these a church will be

erected, at a cost of 100,000 dollars, for the benefit of the university. Miss Helen Gould, daughter of the late Jay Gould, has purchased several acres on Loring and Oxford Avenues, north-east of the university *campus*, which is supposed to be intended as a site for residences of the professors, as Miss Gould has already shown herself interested in the university by endowing twelve scholarships of 5000 dollars each.

THE eclipse expedition, briefly referred to in our notes last week, left Brooklyn on December 5 for Aleeshi, on the island of Yezo, the northernmost of the Japan group, to observe the total eclipse of August 9, 1896. The schooner-yacht *Coronet*, the largest yacht in the New York Yacht Club, 133 feet long and of 152 tons burden, was generously placed at the disposal of Prof. David P. Todd, of Amherst, by her owners, Mr. D. Willis James and Mr. Arthur C. James. The yacht has already become famous as the winner of 10,000 dollars in a race across the ocean with the yacht *Dauntless*, and she has also already once sailed round Cape Horn, going from New York to San Francisco in 105 days. The same course will be taken now, and the time of the voyage may be shortened. On arrival at San Francisco, she will be joined by Prof. and Mrs. Todd, Mr. Arthur C. James and wife, and a corps of scientific workers, and will then proceed to her destination, after a short stop at Honolulu. The equipment will include about three tons of apparatus, comprising twenty-five or thirty telescopes, both refracting and reflecting, fitted with automatic photographic cameras, which will be set to take 400 or 500 photographs of the corona during the totality of the eclipse. The exposures will be of varying length, from half a second up to several seconds, and will be made with a series of graduated discs, so as to take, in some cases, the entire corona, and in others, outer and fainter portions of it. Almost all the work of observation will be thus photographic, and only a single observer will note appearances through a telescope. Most of the apparatus is already stowed in the yacht. The lenses, however, will be taken overland in the spring, when the party go to embark at San Francisco.

ANOTHER important scientific expedition set out on December 5; for on that day Mr. Frank H. Cushing left Washington for St. Augustine, Florida, where he will be joined by a number of assistants, and the party will sail on a schooner to Pine Island, below Punta Gorda and the southern Florida keys, where a thorough investigation, which is expected to last several months, will be made into the recently discovered mounds built by a remarkable people, who attained a high state of civilisation. Mr. Cushing has already discovered well-preserved remains of the "Shell Age" of prehistoric man. Objects of art made from shell, and shell implements, were found well-preserved, among the most remarkable being a shell pick, still mounted on its original handle of mango wood. The expedition is under the joint auspices of the Ethnographical Bureau of the United States and the Archæological Department of the University of Pennsylvania.

A FURTHER example of the keen interest taken by the German Government in all that concerns the development of trade is reported by the Vienna correspondent of the *Times* as follows: "A newspaper in the Japanese language has recently been published at Yokohama under English auspices. The aim of this journal, for which only a very moderate charge is made, is to familiarise the people of Japan with British merchandise. It appears that Germany has convinced herself of the efficacy of the enterprise, for that Government has lately instructed the Legation and the various Consulates to consider and report upon the methods best suited to ensure the success of a similar undertaking on German lines. It is now stated on good authority that the issue of a German newspaper has been definitely decided upon. It will be edited at the Academy of Oriental Languages in Berlin, and will be printed in Germany and forwarded to Japan for distribution among the inhabitants free of charge." One wonders whether, under similar circumstances, our own Government would have sought the assistance of a learned Society or Academy to carry out its projects.

FROM the same source, we learn that an expedition, fitted out at considerable expense by the Lyons Chamber of Commerce, and entrusted with the mission of thoroughly investigating the trade and commerce of Eastern Asia, has arrived in China. The expedition is exclusively composed of experts, who have undertaken to study the means of developing the trade with the interior, and to open up the wealth of the country to European enterprise. Whatever measure of success may attend their efforts, they will, at all events, traverse districts hitherto wholly unexplored. Finally, it is reported that at the initiative of the Blackburn Chamber of Commerce an English expedition will start shortly to explore the western provinces of Szu-chuan and Yun-nan.

ONE thing after another has cropped up lately to call the attention of the Government and the press to the need for an inquiry into the reason why England is behind Germany and other nations in the industrial applications of science. Mr. J. Powell Williams, who is the Financial Secretary to the War Office, has just had to confess that dried vegetables of various kinds, prepared in a particular manner, and required for the Ashanti Expedition, had to be procured from Germany, as they cannot be obtained in this country. Possibly the Government is under the impression that carrots, potatoes, and turnips cannot be grown in England. For if not, why is not something done to find out how they can be reduced to a dried condition suitable for keeping and transportation? There are dozens of chemists who know the processes by which vegetables can be best prepared for future consumption, and who would be glad to assist in the development of a new British industry.

ON Monday, Lord Herschell gave an address on the work of the Imperial Institute, in reply to some of the criticisms which have been levelled against it. He showed that the collections of economic products from India and the colonies had grown, and had been of some use to merchants and manufacturers; he also mentioned a few investigations that had been carried on under the auspices of the Institute, and described the work of the commercial intelligence department. There is one point, however, upon which we should like to say a word. Lord Herschell remarked that, in accordance with the original scheme, the buildings of the Institute had been applied to the reception of Congresses, such as the International Geographical Congress. This gives the idea that the Council of the Institute granted, without payment, the use of their buildings to the Congress; and if that had been done, we should regard the action as worthy of an Institute which professes to encourage science. But we understand that the International Geographical Committee had to pay a sum of £1100 for the use of the Institute buildings for the Congress, besides several hundreds more in incidental expenses, and that the whole business connected with the hire of the buildings was conducted in a strictly commercial spirit. Lord Herschell omitted this plain statement of fact from his address; but a few transactions of this character are more than sufficient to dispel the belief that the Institute has the promotion of science at heart.

THE Russian correspondent of the *Lancet* has learnt from Prof. Erisman, the general secretary to the Congress, that the date fixed for the next International Medical Congress is the week beginning August 19 and ending August 26 (New Style), 1897. The official announcement will very shortly be sent to the English press. The Emperor has given his Imperial sanction to the Congress, and the Grand Duke Sergi Alexandro-

vitch, the governor of Moscow (and grandson-in-law to Queen Victoria), has granted it his patronage. The nominal president will probably be the Minister of Public Education; the acting president will almost certainly be Prof. Klein, the Dean of the Faculty of Medicine in the University of Moscow. Prof. Erisman, who holds the chair of Hygiene, has, as already stated, been elected general secretary. The meetings of the Congress will be held in the theatres and laboratories of the University Clinique, the so-called *klinitcheski gorodok*, or clinical townlet. Papers and discussions must be in either the French or German language; Russian has been excluded lest the Congress should become national rather than international, and English on the grounds that it is a language little used or understood by other than Englishmen.

ON Monday afternoon, in the Botanical Theatre of University College, London, Prof. Bonney was presented with his portrait by former geological students of the University of Cambridge and of University College, London. A large number of past and present pupils were present, and Mr. J. J. H. Teall occupied the chair as Prof. Bonney's senior pupil. Mr. J. E. Marr referred to the affection and esteem in which Prof. Bonney was held by all his pupils, and Miss Raisin spoke on behalf of the lady students. At the conclusion of her remarks, Prof. W. J. Sollas made the presentation on behalf of the subscribers. The portrait having been unveiled, Prof. Bonney replied. In the course of his remarks he advised those who heard him never, if they could help it, to take things on trust. No doubt books were of great value, but before they trusted them they must know the writers. They must gather facts, and, having done so, take a comprehensive view of them and treat them as inductive. They should not be fascinated by brilliant hypothesis, nor try to write too much; for careless observation and unsound induction were rather a curse than a blessing to science.

DR. J. BATTY TUKE has been elected President of the Royal College of Physicians of Edinburgh.

THE largest battery of dynamite guns in the world was tested recently at San Francisco, and found to work satisfactorily.

WE understand that the Bruce photographic telescope is to be transferred from Harvard University at Cambridge, U.S., to the University station at Arequipa, Peru.

THE Council of the Royal Statistical Society have awarded the Howard medal of 1895 to Mr. John Watson, for his essay on "Reformatory and Industrial Schools."

REUTER reports that Dr. Warth, of the Geological Survey of India, while gold-prospecting in Chota Nagpur, Bengal, struck a reef of remarkable richness. The Indian Government has ordered the erection of stamps for trial crushings.

THE deaths of the following men of science are announced:—Dr. Popoff, Extraordinary Professor of Physiology in the University of Dorpat; Dr. A. de Cerqueira Pinto, formerly Professor of Organic Chemistry in Bahia; Dr. Teichmann, formerly Professor of Anatomy in Cracow.

SURGEON-COLONEL C. ROE, who has been appointed honorary secretary of the Association for the establishment of a Pasteur Institute in India, has made an appeal for funds to ensure the success of the scheme. There is little doubt that the required amount will be collected.

THE two following afternoon lectures will be delivered at the Royal Institution in January, in addition to the arrangements already announced: Dr. A. Donaldson Smith, "To the North of Lake Rudolf and among the Gallas," and Mr. Walter R. Lawrence, C.I.E., on "The Valley of Kashmir."

PROF. W. H. DALL recently returned to Washington from an expedition to examine the coal-fields of Alaska. He found and brought back pieces of fat of a mammoth preserved in ice for ages, being the first discovery of the kind in America. He also discovered a species of bear not previously known to zoologists, but apparently familiar to residents of Alaska, and known there as the ice-bear.

THE Automatic Telephone Company has just been incorporated at Albany, and will construct a new system of telephones, which, as the name implies, are self-acting and independent of any central office. Each subscriber can make and discontinue his own connections by means of an improved device. Tests have already been made, and the system will be at once put in use in New York and Brooklyn.

AN advance copy of Appendix I. 1896, to the *Kew Bulletin* has been sent us. It contains a list of seeds of hardy herbaceous annual and perennial plants and of hardy trees and shrubs which, for the most part, have ripened at Kew during the year 1895. These seeds are not sold to the general public, but are available for exchange with colonial, Indian, and foreign botanic gardens, as well as with regular correspondents of Kew. We hasten to publish this information for the benefit of directors of botanic gardens across the seas. No application, except from remote colonial possessions, can be entertained after the end of March next year.

A TELEGRAM from Captain Roborovsky, dated December 4, announces that the Russian Tibet expedition has finally returned to the Russian dominions, at Zaisan, after having crossed Dzungaria, by two different routes, on their way from the Lyukchun depression. The same telegram announces that the expedition, which has covered nearly 10,700 miles and made a survey of the whole route, and determined the positions of thirty points by astronomical observations, returns heavily laden with natural history collections: 280 specimens of mammals, 1300 of birds, 450 of amphibia and fishes, 30,000 of insects, 25,000 (1300 species) of plants, 300 of seeds, and 300 geological specimens. The meteorological station at Lyukchun has been working for fully two years.

IT is satisfactory to learn that the efforts made by the *Engineer*, to secure the repeal of the existing legal restrictions on the use of mechanical road carriages, are being well supported by many who are taking personal interest in the new vehicle. From a note in the current number of our contemporary, it appears that all the necessary steps have been taken to bring the subject before the notice of the Government; that Mr. Chaplin, as President of the Local Government Board, has expressed himself in strong sympathy with the movement, and that the memorial to him, prepared by the *Engineer*, and signed by leading manufacturing firms and engineers all over the country, has now been placed in his hands. The way for the introduction of a Bill has thus been prepared, and an association has already been formed to support the demand for freedom to use mechanical road carriages equal to that now enjoyed for horse-hauled vehicles.

THE death is announced, in the *Times*, of M. A. P. Kostycher, Director of Agriculture in Russia. M. Kostycher was appointed Professor of Agriculture in 1876, and created the first laboratory in Russia for the study of soils and agricultural products. He held this appointment for seventeen years, in the course of which he made some very interesting researches into the nature and origin of the celebrated "black earth," which is such a source of wealth to the 250,000,000 acres of land in Southern Russia. His six volumes on this subject are regarded as standard works. In 1894 he was appointed assistant to M. Yermolof, who had just been placed at the head of the Agricultural Department. M. Kostycher contributed a very elaborate

chapter to the work on agriculture and forestry, which was published by the Russian Government at the time of the Chicago Exhibition, and was translated into English by Mr. J. M. Crawford, the Consul-General at St. Petersburg.

ACTING upon the report of the Departmental Committee on the Screening of Side Lights of Ships, the Board of Trade have issued the following instructions to their surveyors throughout the country:—The Committee appointed by the Board of Trade under minute of March 18, 1895, to consider the question of the screening of side lights have reported, *inter alia:* (1) That the Order in Council of January 30, 1893, be cancelled. (2) That in the case of oil lamps the forward edge of the screen, or chock on it, should be in a line parallel to the keel with the inside edge of the wick. (3) That in the case of electric lights there should be a similar screening in regard to the inside edge of the filament. (4) That the breadth of the wick of oil lamps, and of the filaments in the case of the electric light, should be not more than two inches, nor less than one inch, measured at right angles to the fore and aft line of the ship. The Board having decided to adopt the above recommendations, the surveyors are informed that the instructions as to the screening of side lights contained in the present issue of "Instructions as to the Survey of Passenger Accommodation, Master's and Crew Spaces," "Lights and Fog-signals," so far as they have either direct or indirect reference to the lights being screened to an angle of convergence of 4° from the outside edge of the wick, are no longer to be put in force, but instead thereof the surveyors are to carry out the directions as to screening contained in above paragraphs, numbered 2, 3, and 4.

THE better protection of wild birds was the object of a deputation that waited upon the Home Secretary on Tuesday. The deputation consisted of members of the eight Councils having an area within the Metropolitan Police district. Mr. Montagu Sharpe said they desired to urge (1) that the close time under Section 8 of the Act of 1880 should be extended; (2) that thirteen new species of birds, in addition to those mentioned in Section 3 of the Act of 1894, should be scheduled; and (3) that the eggs of forty-six species of birds should be scheduled for protection under Section 2 of the Act of 1894. It was desired that the close time for wild birds should be extended to the period between February 1 and August 31. The birds which it was sought to add to the list were the wryneck (cuckoo's mate, or snake-bird), swallow, martin (2), swift, bearded tit (reedling and reed pheasant), kestrel, merlin, hobby, buzzard, honey buzzard, osprey, magpie, and shrike. These birds should be protected not only for their beauty, but for their usefulness in destroying noxious insects, mollusca, and rodents, which were particularly destructive in suburban gardens. The Home Secretary expressed agreement with the proposals of the deputation, and said he would comply with their desire with regard to the scheduling of birds and their eggs.

AN improvement on the simple pendulum for purposes of measurement is described by G. Guglielmo in the *Atti dei Lincei.* The simple pendulum oscillates about its point of suspension in all directions. The compound pendulum rests on a knife-edge, or essentially on two points some distance apart, and therefore oscillates always in the same plane. A bob suspended by two threads will do the same, and will have the additional advantage of simplicity. But for some purposes it is highly desirable to have a body oscillating in the same plane, and parallel to itself. Sgr. Guglielmo has accomplished this by taking two such bifilar pendulums and joining them by a horizontal rod placed in their plane of vibration. This contrivance can be used for a variety of purposes. An electrometer is described in which the rod is replaced by a small cylinder moving inside another, and displaced by any difference of potential between the two. A very useful application of it is the anemometer designed on this plan. A vertical disc is fixed on one end of the rod, and exposed directly to the wind. Wild's anemometer, which consists of a simple plate, the inclination of which alters with the strength of the wind, does not give the horizontal velocity of the wind in a simple manner. The new anemometer always exposes a vertical disc to the wind, and the force is directly given by the deflection of the suspending wires. It should be mentioned that the suspending wires are of iron, joined to the rod and to the supports by short lengths of silk thread to ensure flexibility. Many interesting investigations may be carried out with this apparatus: the influence of the inclination of the disc may be studied, and the indications of Robinson's revolving anemometer may be verified. Oscillations are effectively damped by a wire attached to the rod with a disc attached to its lower end and immersed in water.

WITH the scientific intelligence in the December number of the *American Journal of Science,* we find the following note on underground temperatures at great depths, received by the editors from Prof. A. Agassiz:—"For several years past I have, with the assistance of our engineer, Mr. Preston C. F. West, been making rock temperature observations as we increased the depth at which the mining operations of the Calumet and Hecla Mining Company were carried on. We have now attained at our deepest point a vertical depth of 4712 feet, and have taken temperatures of the rock at 105 feet, at the depth of the level of Lake Superior, 655 feet, at that of the level of the sea, 1257 feet, at that of the deepest part of Lake Superior, 1663 feet, and at four additional stations, each respectively 550, 550, 561, and 1256 feet below the preceding one, the deepest point at which temperatures have been taken being 4580 feet. We propose, when we have reached our final depth, 4900 feet, to take an additional rock temperature, and to then publish in full the details of our observations. In the meantime it may be interesting to give the results as they stand. The highest rock temperature obtained at the depth of 4580 feet was only 79° F.; the rock temperature at the depth of 105 feet was 59° F. Taking that as the depth unaffected by local temperature variations, we have a column of 4475 feet of rock with a difference of temperature of 20° F., or an average increase of 1° F. for 223·7 feet. This is very different from any recorded observations; Lord Kelvin, if I am not mistaken, giving as the increase for 1° F., fifty-one feet, while the observations based on the temperature observations of the St. Gothard tunnel gave an increase of 1° F. for sixty feet. The calculations based upon the latter observations gave an approximate thickness of the crust of the earth, in one case of about twenty miles, the other of twenty-six. Taking our observations, the crust would be over eighty miles, and the thickness of the crust at the critical temperature of water would be over thirty-one miles, instead of about seven, and 8·5 miles as by the other and older ratios. With the ratio observed here, the temperature at a depth of nineteen miles would only be about 470°, a very different temperature from that obtained by the older ratios of over 2000° F. The holes in which we placed slow registering Negretti and Zambra thermometers were drilled, slightly inclined upward, to a depth of 10 feet from the face of the rock, and plugged with wood and clay. In these holes the thermometers were left from one to three months. The average annual temperature of the air is 48° F., the temperature of the air in the bottom of the shaft was 72° F."

THE first part of a cheap edition of "Science for All" has just been published by Messrs. Cassell and Co. So far as we can see, few revisions have been made; hence the work in nowise represents the state of scientific knowledge at the present time.

UNDER the title, "Neue Gedanken zur Vererbungsfrage," the original German text of the article by Dr. Weismann in the *Contemporary Review* for September, has been published by Gustav Fischer, Jena. The article was a reply to one by Mr. Herbert Spencer, in the *Contemporary* of October 1894, and was written at the beginning of this year; but the time taken to translate it into English caused its publication to be delayed until September.

THE Cambridge University Press will publish in a few weeks a comprehensive work on "Ethnology," by Prof. A. H. Keane. The work is divided into two parts, the first dealing with those fundamental problems which affect the human family as a whole, the second discussing those general questions which concern the primary human groups. Evolutionary principles are taken as the basis of construction throughout the work.

THE "Live Stock Journal Almanac" for 1896 has been published by Messrs. Vinton and Co. It contains an abundance of information on all points connected with the breeding and management of live stock, and is plentifully illustrated. Among the articles we notice "Feeding Pastures," by Mr. W. Carruthers, F.R.S.; "Factors in Horse Breeding," by Captain M. H. Hayes; and "Four Feathered Friends," by Mr. A. F. Lydon. The last-named article will do good by showing agriculturists the usefulness of the linnet, chaffinch, goldfinch, and yellow-hammer.

SEVERAL valuable papers on fruit-growing appear in the *Journal* of the Royal Horticultural Society (vol. xix. part 2, November). M. Charles Baltet, President of the French Pomological Congress, describes the principal points connected with the cultivation of fruit in France, and enumerates the principal varieties recommended to fruit-growers, whether amateurs cultivating for home consumption, or farmers for commercial purposes. At a conference held in September, Mr. G. Bunyard described a number of fruits recently brought to the front; Mr. A. H. Pearson gave a paper on pruning fruit-trees; and a prize essay on the commercial aspect of hardy fruit-growing was read. It may be remembered that in the early spring of this year, the Society offered a prize of £10 for the best essay on this subject. Two essays were selected as of equal merit, and the prize, increased by £5, was divided between the authors, Mr. Lewis Castle and Mr. S. T. Wright. Both these essays are printed in full in the *Journal* before us, and we have no doubt that they will give an effective impulse to the cultivation of fruit in this country.

THE additions to the Zoological Society's Gardens during the past week include a Moor Monkey (*Macacus maurus*, ♀) from the East Indies, presented by Mr. Granville Bantock; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. Charles Henderson; three American Jabirus (*Mycteria americana*) from the Island of Marajo, North Brazil, presented by Mr. H. A. Astlett; a Spotted Eagle Owl (*Bubo maculosa*) from East Pondoland, South Africa, presented by Mr. R. W. Murray; a Woodcock (*Scolopax rusticula*), British, presented by Mr. Charles Smoothy; two Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. J. Palmer; a Hoary Snake (*Coronella cana*) from South Africa, presented by Mr. J. E. Matcham; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, a Leopard Tortoise (*Testudo pardalis*) from South Africa, deposited; a Black-necked Stilt Plover (*Himantopus nigricollis*) from South America, nine Long-eared Sun Fish (*Lepornis auritus*), five Rock Bass (*Ambloplites rupestris*), six Catfish (*Amiurus catus*) from North America, a Reeves's Terrapin (*Clemmys reevesi*) from China, two Red-headed Pochards (*Fuligula cerina*), European, purchased.

OUR ASTRONOMICAL COLUMN.

COMETS BROOKS AND PERRINE.—The following ephemeris for Comet Brooks, for Berlin midnight, is by Dr. Berberich (*Ast. Nach.*, 3321):—

	R.A. h. m. s.	Decl. ° ′
Dec. 19	5 8 5	+67 59·0
20	4 50 45	68 27·9
21	34 19	68 47·3
22	18 56	68 58·9
23	4 4 39	69 4·2
24	3 51 30	69 4·5
25	39 29	69 0·9
26	3 28 33	+68 54·2

Comet Perrine is now moving northwards, and is becoming more favourably placed for observation, as shown in the following extract from Dr. Lamp's ephemeris for Berlin midnight (*Ast. Nach.*, 3322):—

	R.A. h. m. s.	Decl. ° ′	Brightness.
Dec. 19	18 31 25	−30 18·4	57·0
20	43 16	29 16·0	
21	52 14	28 6·0	35·3
22	18 59 0	26 55·6	
23	19 4 8	25 47·3	20·4
24	8 6	24 42·6	
25	11 16	23 42·1	12·3
26	19 13 53	−22 45·4	

The brightness on November 18 is taken as unity.

A NEW OBSERVATORY.—We learn from *Science* that the Legislature of Minnesota has granted £2000 for the erection of a student's observatory at the University of Minnesota. The building is already under roof, and is promised for use by January 1, 1896. The equipment will include a 10-inch equatorial of 150 inches focal length. This instrument is to have a triple objective, one combination of which will form the visual telescopic objective, and another the photographic objective. A spectroscope and photograph measuring machine are among the accessories soon to be added. Upon the completion of this working observatory, Prof. Leavenworth will use it to carry on advanced instruction in astronomy.

PHOTOGRAPHY OF MINOR PLANETS.—Dr. Max Wolf, who has taken a prominent part in the detection of new minor planets by the trails which they leave on a photographic plate during a long exposure, describes his method of work in some detail in *Ast. Nach.*, 3319. His photographic telescope consists of a 6-inch portrait lens of 30 inches focal length, and giving a field of about 70 square degrees. In order to distinguish between true planetary trails and defects of the plates, two photographs of each region are taken, the necessary exposures usually not being more than two hours. One of the best methods of detecting differences between two photographs of the same region is to compare a positive with a negative, the films being in contact; the two trails will then be seen in continuation of each other if they are real. Another method of detecting the trails readily is to employ a stereoscope for viewing the two photographs, the change of position bringing out the planet in relief. As might be expected from the instrument employed, measurements of the photographs do not furnish positions with any great degree of accuracy, but they serve as a guide to observers using instruments of greater precision.

It is somewhat remarkable that Dr. Wolf has not telescopically observed any one of the numerous planets which he has discovered by the photographic method.

SHORT PERIOD VARIABILITY.—The recent researches on the spectra of short-period variable stars, more especially of δ Cephei, have no doubt led many to inquire into the possible explanations of the phenomena observed. Among others, Mr. A. W. Roberts, an assiduous observer of this type of variable in the southern hemisphere, has given attention to the subject (*Astrophysical Journal*, November, p. 283). Omitting the Algol variables, which are perhaps sufficiently explained by eclipses, and β Lyræ, which may provisionally be considered as a special case, any satisfactory theory must explain the relative rapidity of the rise to maximum, continuity of variation throughout the period, and the small range of the light changes. In the case of δ Cephei, Belopolsky has shown that the variability is intimately connected with its revolution, the star being apparently

associated with a relatively dark body; and it is perhaps allowable to suppose a similar connection in the case of other variables of the same class. Besides the possibility of eclipses, this orbital movement may operate in two other ways to produce light changes. If the companion be a dark body, there will be phases depending upon its varying reflection of light from the primary, but the changes of magnitude due to this cause will be practically negligible. When the orbit is very eccentric, as in δ Cephei, the temperature of the companion will vary very considerably at different parts of the revolution, and Mr. Roberts seems to regard its consequent changes of brightness as probably the main cause of the variability. It is admitted, however, that the variations of 1·5 or 2 magnitudes, which are occasionally met with, cannot be satisfactorily explained in this way, and it is necessary to suppose an additional variation of the primary itself due to disturbances at periastron. In the variables, like η Aquilæ, which show a secondary minimum, it is only necessary to suppose that an eclipse also takes place. Attention is drawn to two tests of this theory. First, the companion should show itself spectroscopically at the quadrature following periastron; second, telescopic double stars having highly eccentric orbits should exhibit fluctuations of magnitude depending upon the distance between the components. It should be remembered that there is as yet no evidence of luminosity of the companion to δ Cephei, but it may be that the exposures given to the spectrum photographs have been insufficient to depict it.

THE NEW MINERAL GASES.[1]

As Mr. Crookes has now published (*Chemical News*, August 23, 1895), the wave-lengths of the lines in the spectra of the new mineral gases observed by him in the tubes supplied by Prof. Ramsay, I propose in the present paper to bring together some notes I have made (some of them some time ago) on the same subject.

The researches made at Kensington in connection with the new gases obtained from bröggerite and other minerals has consisted, to a large extent, of comparisons of the lines in their spectra with lines in the spectra of the sun and stars. Preliminary accounts of these comparisons have already been given, and they show that the bright yellow line seen in the gas from bröggerite is by no means the only important one which appears.

Although the general distribution and intensities of the lines in the gases from bröggerite and cleveite sufficiently corresponded with some of the chief "unknown lines" in the solar chromosphere and some of the stars to render identity probable, it was desirable to see how far the conclusion is sustained by detailed investigations of the wave-lengths of the various lines.

The Yellow Line λ 5875·9.—Immediately on receiving from Prof. Ramsay, on March 28, a small bulb of the gas obtained from cleveite, a provisional determination of wave-length was made by Mr. Fowler and myself, in the absence of the sun, by micrometric comparisons with the D lines of sodium, the resulting wave-length being 5876·07 on Rowland's scale. It was at once apparent, therefore, that the gas line was not far removed from the chromospheric D_3, the wave-length of which is given by Rowland as 5875·98.

The bulb being too much blackened by sparking to give sufficient luminosity for further measurements, I set about preparing some of the gas for myself by heating bröggerite *in vacuo*, in the manner I have already described. A new measurement was thus secured on March 30 with a spectroscope having a dense Jena glass prism of 60°; this gave the wave-length 5876·0.

On April 5, I attempted to make a direct comparison with the chromospheric line, but though the lines were shown to be excessively near to each other, the observations were not regarded as final.

Prof. Ramsay having been kind enough to furnish me, on May 1, with a vacuum tube which showed the yellow line very brilliantly, a further comparison with the chromosphere was made on May 4. The observations were made by Mr. Fowler, in the third order spectrum of a grating having 14,438 lines to the inch, and the observing telescope was fitted with a high power micrometer eye-piece; the dispersion was sufficient to easily show the difference of position of the D_3 line on the east and west limbs, due to the sun's rotation. Observations of the chromosphere were therefore confined to the poles.

During the short time that the tube retained its great brilliancy, a faint line, a little less refrangible than the bright yellow one, and making a close double with it, was readily seen; but afterwards a sudden change took place, and the lines almost faded away. While the gas line was brilliant, it was found to be "the least trace more refrangible than D_3, about the thickness of the line itself, which was but narrow" ("Observatory Note Book"). The sudden diminution in the brightness of the lines made subsequent observations less certain, but the instrumental conditions being slightly varied, it was thought that the gas line was probably less refrangible than the D_3 line by about the same amount that the first observation showed it to be more refrangible. Giving the observations equal weight, the gas line would thus appear to be probably coincident with the middle of the chromospheric line, but if extra weight be given to the first observation, made under much more favourable conditions, the gas line would be slightly more refrangible than the middle of the chromosphere line.

Pressure of other work did not permit the continuation of the comparisons. In the meantime, Runge and Paschen announced (NATURE, vol. lii. p. 128) that they also had seen the yellow line of the cleveite gas to be a close double, neither component having exactly the same wave-length as D_3, according to Rowland. They give the wave-length of the brightest component as 5878·883, and the distance apart of the lines as 0·323.

This independent confirmation of the duplicity of the gas line led me to carefully re-observe the D_3 line in the chromosphere for evidences of doubling. On June 14 observations were made by Mr. Shackleton and myself of the D_3 line in the 3rd and 4th order spectra under favourable conditions; "the line was seen best in the 4th order, on an extension of the chromosphere or prominence on the north-east limb of the sun. The D_3 line was seen very well, having every appearance of being double, with a faint component on the red side, dimming away gradually; the line of demarcation between the components was not well marked, but it was seen better in the prominence than anywhere else on the limb" ("Observatory Note Book").

It became clear, then, that the middle of the chromosphere line, as ordinarily seen, and as taken in the comparison of May 4, does not represent the place of the brightest component of the double line, so that exact coincidence was not to be expected.

Though the observations are not yet quite completed, the circumstance that the line is double in both gas and chromosphere spectrum, in each the less refrangible component being the fainter, taken in conjunction with the direct comparisons which have been made, render it highly probable that one of the gases obtained from cleveite is identical with that which produces the D_3 line in the spectrum of the chromosphere.

Other observers have since succeeded in resolving the chromospheric line. On June 20, Prof. Hale found the line to be clearly double in the spectrum of a prominence, the less refrangible component being the fainter, and the distance apart of the lines being measured as 0·357 tenth-metres (*Ast. Nach.*, 3302).

The doubling was noted with much less distinctness in the spectrum of the chromosphere itself on June 24. Prof. Hale points out that Rowland's value of the wave-length (as well as that of 5875·924, determined by himself on June 19 and 20) does not take account of the fact that the line is a close double.

Dr. Huggins, after some failures, observed the D_3 line to be double on July 10 (*Ast. Nach.*, 3302); he also notes that the less refrangible component was the fainter, and that the distance apart of the lines was about the same as that of the lines in the gas from cleveite, according to Runge and Paschen.

It may be added, that in addition to appearing in the chromosphere, the D_3 line has been observed as a bright line in nebulæ by Dr. Copeland, Prof. Keeler, and others; in β Lyræ and other bright line stars; and as a dark line in such stars as Bellatrix, by Mr. Fowler, Prof. Campbell, and Prof. Keeler. In all these cases it is associated with other lines, which, as I shall show presently, are associated with it in the spectra of the new gases.

The Blue Line, λ 4471·8.—A provisional determination on April 2 of the wave-length of a bright blue line, seen in the spectrum of the gases obtained from a specimen of cleveite,

[1] "On the New Gases obtained from Uraninite. (Sixth Note.)" By J. Norman Lockyer, C.B., F.R.S. Received at the Royal Society, September 10, read November 21.

showed that it approximated very closely to a chromospheric line, the frequency of which is stated as 100 by Young.

This line was also seen very brilliantly in the tube supplied to me by Prof. Ramsay on May 1, and on May 6 it was compared directly with the chromosphere line by Mr. Fowler. The second order grating spectrum was employed. The observations in this region were not so easy as in the case of D_3, but with the dispersion employed, the gas line was found to be coincident with the chromospheric one. In this case also, the chromosphere was observed at the sun's poles, in order to eliminate the effects due to the sun's rotation.

In a former note (*Roy. Soc. Proc.*, vol. lviii. p. 114), I have pointed out that this line does not appear in the spectra of the gases obtained from all minerals which give the yellow line.

Besides appearing in the spectrum of the chromosphere, the line in question is one of the first importance in the spectra of nebulæ, bright line stars, and of the white stars such as Bellatrix and Rigel.

The Infra-red Line, λ 7065·5.—In addition to D_3 and the line at 4471·8, there is a chromospheric line in the infra-red which also has a frequency of 100, according to Young. On May 28, I communicated a note to the Royal Society stating that this line had been observed in the spectrum of the gases obtained from bröggerite and euxenite (*Roy. Soc. Proc.*, vol. lviii. p. 192), solar comparisons having convinced me that the wave-length of the gas line corresponded with that given by Young; and I added, "it follows, therefore, that besides the hydrogen lines, all three chromospheric lines in Young's list which have a frequency of 100 have now been recorded in the spectra of the new gas or gases obtained from minerals by the distillation method."

M. Deslandres, of the Paris Observatory, has also observed the line at 7065 in the gas obtained from cleveite (*Comptes rendus*, June 17, 1895, p. 1331).

Other Lines.—Determinations of the wave-lengths of many other lines in the spectra of the new gases have been made, chiefly with the aid of a Steinheil spectroscope having four prisms, and the results leave little doubt as to the coincidence of several lines with those appearing in the chromosphere, nebulæ, and white stars.

It seems very probable, also, that many lines which have been noted, and for which no origins have yet been traced, belong to gases which have not hitherto been recorded in the chromosphere.

The following table summarises the chief lines which have so far been recorded in the new gases from various minerals, some of which show D_3 while others do not. Only those lines which also appear in the spectrum of the chromosphere, nebulæ, or Orion stars, are given in the first instance. There are other lines which are probably also associated with chromospheric ones, but further investigation of them is considered desirable before they are included in the list.

Wave-length (Rowland).	Wave-length (Angström).	Chromosphere (Young).	Eclipses 1893. Max. intens. = 10.	Orion nebula. Max. intens. = 6.	Bellatrix. Max. intens. = 6.	Crookes' measures.
		Frequency	λR	λR	λR	λR
7065·5	7064·0	100	...	...	...	7065·5
6678·3	6676·9	25	...	...	...	6678·1
6371·6	6370·5	5				
6347·3	6346·2	10				
6141·9	6140·6	15				
6122·43	6121·43	5				
6065·7	6064·5	5				
5991·6	5990·0	15				
5875·9	5874·9	100	5876·0	5876·0	5876·0	5876·0
5429·9	5428·8	8				
5404·1	5403·1	5				
5048·2	5047·8	2	...	...	...	5047·1
5015·8	5015·0	30	5016·0(4)	...	5016·0(1)	5015·9
4922·3	4921·3	30	4922·0(4)	4924(3)	4922·0(2)	4922·6
4713·4	4712 5	2	4713·2(5)	4716(2)	4715·0(3)	4713·4
4471·8	4471·2	100	4471·8(10)	4472(4)	4472·0(6)	4471·5
4389·5	4388·5	1	4390·0(1)	4390(2)	4389·0(5)	4386·3
4026·5	4025·9	*	4026·0(6)	4026(3)	4026·0(6)	4026·1
3964·0	3963·5	—	3963·8	...	3964·0(3)	3964·8
3888·7	3888·0	—	probable†	...	probable	3888·5

* Prof. Young has recently called attention to the fact that although this line was not included in his chromospheric list, he observed and published it in 1883; its frequency is about 15. (NATURE, vol. lii. p. 458.)

† This line is too close to a hydrogen line to enable a definite statement to be made.

The first column of the table gives the wave-lengths of the lines on Rowland's scale, while the second gives the wave-lengths on Ångström's scale; the third gives the frequency of the lines in the chromosphere according to Young. In the fourth column lines photographed with the prismatic camera during the total eclipse of April 16, 1893, are shown; these have been included because in some cases lines which appear to be comparatively unimportant in Young's list were photographed as important lines. The fifth column indicates probable coincidences with lines in the spectrum of the Orion nebula; the accuracy of these wave-lengths is of necessity less than in the case of the chromosphere; with the exception of D_3 they are taken from my paper on the photographic spectrum of the Orion nebula (*Phil. Trans.*, 1895, vol. 186A, p. 76). The sixth column shows probable coincidences with dark lines in the spectrum of Bellatrix, this being taken as an example of the Orion stars (*Phil. Trans.*, 1893, vol. 184A, p. 695), the lines 4922·3 and 5015·8 have been photographed since the date of the paper to which reference is made.

The last column gives the wave-lengths, from Mr. Crookes' table, of the lines observed by both of us.

THE DUKE OF DEVONSHIRE ON EDUCATION.

WITHIN the past few days, the Duke of Devonshire has delivered several orations on educational topics. Two of these addresses appeal especially to those who are interested in technical and scientific education: one was delivered at the annual meeting of the National Association for the Promotion of Technical and Secondary Education, to representatives of technical educational committees of county and borough Councils; and the other was a speech to students at the Birmingham Municipal Technical School. We print extracts from the *Times* reports of both addresses, taking them in the order in which they were delivered. To the conference arranged by the National Association, the Duke of Devonshire said:—

It was originally proposed to hold the conference in July, but that was prevented by the occurrence of the general election. While the general election was responsible for the postponement of the conference, it has also had the effect of converting your president from a private individual, entirely irresponsible, whose saying and doings were entirely his own and committed no one, into a member of the Government, who is responsible both to his colleagues and to Parliament. He happens to be not only a member of the Government, but the person who, with my friend Sir John Gorst, is chiefly charged with the direction of educational questions, and also with the administration of large funds, which are administered by the Science and Art Department as well as the Education Department, and he who, therefore, is concerned with technical and secondary as well as elementary education. This change in the position of your president has occurred at a moment when public attention has been very urgently and earnestly directed both to the question of elementary education, which, in the opinion of some persons, has begun to some extent to trespass upon ground that properly belongs to secondary education, and also by the publication of the report of the Royal Commission on Secondary Education.

We have in the report of the Commission a general review of the history of secondary education in this country, of its present position, and suggestions for its future guidance. Great pains have been taken by the Executive Committee of this Association to give in their journal a trustworthy summary of the work which has thus been undertaken by the County Councils. It will be seen that the plans which have been adopted vary greatly in different counties, and while it is most desirable that the special character of each locality should be considered and a wide scope should be given to experiments, and while not even mistakes and some waste of money inseparable from experimental procedure need be wholly regretted, it has been thought that the time has now come when a more uniform system may be encouraged and adopted. In conclusion, I think I may say that, without attempting to anticipate how soon or how completely it may be in the power of any Government to ask Parliament to consider in a more full and comprehensive manner the organisation of secondary education, including technical instruc-

tion throughout the country, it must be recognised that a great deal of work is at present being done, some of which, we may hope, is of very high practical utility, and all of which is of the highest experimental value. That work is being carried on by local and representative authorities, and it cannot but be an advantage that those who are engaged in it should avail themselves of the opportunity now afforded to them of conference and consultation with each other, and thus finding some of the guidance which, under a more completely and thoroughly organised system, they might possibly look for from some central authority.

On Friday last, the Duke of Devonshire opened the new buildings of the Municipal Technical School at Birmingham, and, in the evening of the same day, he distributed the prizes to students in the school, and delivered an address. The following is a condensed report of his remarks:—

The first question which perhaps may occur to some of you is, "Why am I here at all; why am I selected to address this great meeting?" I have been told before to-day, and I have been told again to-night by the Mayor, that it is as President of the Council and head of the Education Department that I am here. I need scarcely tell you that in the somewhat remarkable arrangements which control appointment to the great political offices it does not follow at all that because a politician is appointed to be the head of the Education Department he should know anything whatever about education. The fact that I hold that office and that others have held that office before me who know as little about education as I do, must convince you that the mere fact of my holding that office does not confer upon me any special qualification for the part I am expected to take to-night, and I am afraid before the conclusion of my address some of you may be reminded of the lines of the poet Pope, who, in speaking of the presence of flies in amber, said:—

> "The things, we know, are neither rich nor rare,
> But wonder how the—something—they got there."

I know no more of science or of art than could be put into the capacity of a couple of nutshells, but every member of Parliament is supposed to know something about education. Unfortunately for my own peace of mind, upon one occasion, some years ago now, I happened to be called upon to distribute prizes at a polytechnic institute in London, where I made some observations upon what I thought was an urgent and growing necessity for a greater amount of attention being paid to the scientific and technical education of our people, which appeared to attract some considerable attention. On the strength, I believe, of that speech, I was asked to assume the post of president of a national association for the promotion of technical and secondary education, and since that unhappy moment my life has been more or less a burden to me, and I have been called upon on more occasions than I care to remember to deliver some observations upon subjects of a scientific and an educational character.

It does not require a scientific or educational expert to show that the work which has been done and is being done and is going to be done here is part of a work which is going on all over the country, and which it is for the working population of this country to take or to leave as they please, but it is a work which it is necessary should be done if we intend to maintain not only the industrial supremacy which we have hitherto enjoyed, but even our existence as a great industrial nation. Even upon such a subject as this I can pretend to speak with no authority. All that I have done upon former occasions and all that I can do now is to refer to what has been said by those who can speak upon such a subject with greater authority than I can. Prof. Huxley was one of those who have taken a lead in this movement for the extension of scientific and technical training. These words of his have been quoted before in this hall, but I shall make no excuse to you for quoting them again. He said:—"We are at present in the swim of one of those vast movements in which, with a population far in excess of that which we can feed, we are saved from a catastrophe through the impossibility of feeding them solely by our possession of a fair share of the markets of the world, and in order that that fair share may be retained it is absolutely necessary that we should be able to produce commodities which we can exchange with food-growing people, and which they will take rather than those of our rivals, on the ground of their greater cheapness or their greater excellence. That is the whole story. Our course, let me say, is not actuated by mere motives of ambition or by mere motives of greed. Those, doubtless, are visible enough on the surface of these great movements, but the movements themselves have far deeper sources. Our sole chance of succeeding in the competition which must constantly become more and more severe is that our people shall not only have the knowledge and the skill which are required, but that they shall have the will and the energy and the honesty without which neither knowledge nor skill can be of any permanent avail."

I should like to add a commentary on those words which was supplied, also, I think, on an occasion similar to this, by Sir Henry Roscoe, who has taken a distinguished and a leading part in this movement. Having quoted those words of Prof. Huxley which I have read, Sir Henry Roscoe said: "This great endeavour to place our population in a position to obtain the industrial supremacy which it has long held and to ensure that supremacy is surely of more fundamental importance than any passing political question of the day. Upon the successful solution of this problem depends our very national existence. Pressed on all sides by the superior scientific education of Germany, by the boundless physical resources and indomitable energy of America, we in this country should have enough to do to hold our own in the coming struggle for existence. Hitherto we have rested content with that pre-eminence which our coal and our iron, our insular position, the energy and capability of our race, have given us; such a state of contentment is at the present time a delusion and a snare. We can afford no longer to live in a false paradise. Our competitors have adopted our industrial methods; they have bought our machinery, and are now not only treading on our heels but are surpassing us. Our competitors have adopted our own discoveries and inventions, and are, as it were, working out our own designs. Watt, Stephenson, Arkwright and Crumpton, Whitworth and Bessemer, have made the world akin in more senses than one. Rapid and cheap transit has revolutionised commerce and industry, and raw materials flow in and finished products flow out, and it is to the nation as well as to the men which furnishes that finished article most cheaply and best that victory comes. This, then, is the meaning of technical and industrial training—to fit our people from top to bottom, from the future leader of industry to the lowest handworker, with the means, so far as education can do so successfully, to carry out his life's work. This is the great task we have set ourselves to accomplish." I ask you whether in your opinion this language is exaggerated. I do not think that any man of business who is present here this evening will deny the increasing strain of the competition to which we are exposed. He may not accept the remedies which we suggest, but he will not deny the existence of a danger which we fear.

No one, I think, can doubt the closeness of the connection in the present day between science and industrial pursuits—scientific discovery on the one hand and mechanical invention on the other. These are the factors of industrial progress in this or in any other country. Scientific discovery has made known to us the new properties and qualities of matter; and mechanical invention, on the other hand, has applied those discoveries to industrial processes. How can we expect that our nation can take full advantage of those discoveries; how can we expect that we can satisfy the wants of the world which expects to be put in instant possession of all the advantages of these successful discoveries, unless we have trained managers and foremen who are competent to take instant advantage of every one of those discoveries in science or mechanical invention and possess the scientific skill to apply them; and how can we obtain these managers and foremen unless we place within the reach of the great masses of our people and of our working men facilities for acquiring that scientific knowledge? I may further ask you, can these managers and foremen themselves expect to make the most of their own abilities without the assistance of workmen whose eye and whose hand and whose intelligence have been properly trained to carry out their instructions?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—For many years the annual reports of the University Extension Delegacy have recorded steady progress in the work committed to its supervision. The report just issued shows that, from September 1894 to May 1895, 1544 lectures were delivered in connection with the Delegacy. The

umber of courses organised by Local Committees showed an increase over those of previous years, but the courses given in connection with County Councils showed a decline. This is because the County Councils have appointed lecturers of their own to carry on the work of the Extension lectures; and because fixed colleges or institutes are taking the place of peripatetic teaching. Oxford centres have never shown a preference for courses of lectures on science subjects: in 1894–95, 142 courses were delivered on history, literature, economics, and art, and fifty-seven courses on various branches of science. That the lectures delivered under the auspices of the Delegacy appeal to a large class is shown by the fact that the aggregate of average attendances during the year covered by the report was 20,809.

MR. HENRY A. MIERS, of the Department of Minerals in the British Museum, has been elected Waynflete Professor of Mineralogy, in place of Prof. Story Maskelyne, resigned.

THE following are among recent appointments abroad: Dr. P. Ehrlich to be Professor of Special Pathology and Therapeutics in the Berlin University. Dr. Janny, *privat-docent* in Surgery, at Budapest, to be Professor; Dr. J. Nevinny to be Ordinary Professor of Pharmacology at Innsbruck; Dr. K. A. Bier to be Extraordinary Professor of Surgery at Kiel; Dr. A. Monti to be Professor of General Pathology at Palermo; Dr. Augustin to be Extraordinary Professor of Meteorology in the Bohemian University at Prague.

THE *Times*, in some noteworthy remarks upon the Duke of Devonshire's Birmingham speech, pointed out the importance of technical education, and the necessity for instruction in fundamental principles. "The people perish for lack of knowledge," remarked our contemporary, "but it is primarily general knowledge that they require. Only upon that foundation can technical knowledge be built up with any chance of obtaining its full advantages. . . . Too much stress cannot be laid upon the cardinal importance of equipping our industrial population with the knowledge which at present is far more copiously and systematically provided by other nations than by ourselves. Indeed, we may question whether even among educational reformers full recognition has yet been given to the fact that time and energy are limited quantities. Is it enough to superadd technical education to a stereotyped course of verbal study? Do we not, in that way, not only waste time which might be much better employed, but postpone the acquirement of manual dexterities to too late a period? It is worth serious consideration whether what is wanted for an industrial population at the present day is not an education essentially technical and practical from a very early age, with the verbal training that now passes for education relegated to a secondary place."

THOUGH in recent years there has been a development of facilities for science instruction for boys, and methods of instruction are slowly being improved, the same kind of advances have not been made in girls' schools. This deficiency was discussed at a meeting held at the Hugh Myddelton School last week, when a paper on "Science Teaching for Girls," was read by Mr. Heller, and the essential points of sound teaching of science were dwelt upon. It was pointed out that the teaching of scientific method rather than the teaching of science subjects should be made a valuable educating factor in all schools; that all such teaching must follow the lines of an investigation, must be accurate and quantitative, and must have a logical sequence; that the scholars must be taught to help and think for themselves, and that the teacher should act rather as an exhaust pump than as a force pump, in extracting facts from the child's brain rather than supplying them. Mr. Heller then sketched a syllabus and scheme of work he is carrying out both with classes of teachers and children in East London, where all facts are discovered by experiment, and nothing is given on the *ipse dixit* of the teacher. Referring to the pioneer work the London School Board is carrying out in the training of teachers, the lecturer proposed the following resolution: "That in the opinion of this meeting the time has arrived when the teaching of scientific method should be made an educating influence in girls' schools, and that such teaching must be of an experimental and investigating nature." In the discussion that followed, Dr. Gladstone urged that all knowledge should be gained by scientific methods, and that no special subjects should be taught even in the higher standards of elementary schools, but rather fundamental principles. Dr. Armstrong thought the time was ripe for great changes. In every direction educational authorities were adopting such work as they had heard described. There was no necessity to teach science, but to form character by teaching scientific methods. He advocated the teaching of mental drill and mental discipline, and in conclusion seconded the resolution, which was carried unanimously.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 11.—Emissivity of bodies at high temperatures, and the Auer burner, by Ch. E. St. John. The Auer burner only shows very slight fluorescence and phosphorescence. A thin sheet of oxide on electrically-glowed platinum foil does not assume the temperature of the platinum. The emissivities of glowing bodies are best compared by introducing them into a stove whose walls are at a uniform temperature. The oxides composing the Auer incandescent gas-burner show a high emissive power, which, together with its small mass, large surface, and low conductivity, accounts for its efficiency as an illuminant.—The true surface tension of pure water between 0° and 40° C., by P. Volkmann. This was determined by capillary tubes, and controlled by similar observations upon toluol and benzol. Under a pressure of 750 mm. of moist air, the surface tension of pure water was found to be 7·683 mg. per mm. at 0°, 7·543 at 10°, and 7·236 at 30° C.—Condensation of vapours, by Mathias Cantor. The capillary constants of a surface exert a decided influence upon the dew-point of a vapour in contact with it. The author allowed steam to condense on a thin sheet of petroleum spread on mercury. As soon as the thickness of the layer so deposited is equal to the radius of molecular action, the dew-point and the temperature of saturation become the same. This radius was calculated from the results obtained, and was found to be $6{\cdot}5 \times 10^{-6}$ mm., or slightly less than that found by Reinold and Rücker from soap-bubbles.—Relation between the dielectric constant of a gas and its chemical valency, by Robert Lang. This is an important new law connecting the specific inductive capacity of a gas with its chemical valency. Whatever the nature of the gas, its (sp. ind. capacity − 1) increases directly as the total valency of the atoms constituting its molecules. This difference from unity is called by the author the "electrification number," since it indicates the difference of behaviour in the dielectric ether due to the presence of matter. The electrification numbers of H, O, CO, and CO_2 are very nearly as 1 : 2 : 3 : 4.—Dielectric constants of liquefied gases and the Mossotti-Clausius formula, by F. Linde. These constants of liquefied CO_2, Cl, and N_2O were determined by means of the electric oscillation method. On plotting the calculated and observed values different curves were obtained, and it was evident that the spec. ind. capacity depends upon other conditions besides density.—Circular magnetisation of iron wires, by I. Klemencic. When a current traverses an iron wire, the molecules tend to arrange themselves in circular chains round the axis. This gives rise to strong extra currents at break. The magnetic susceptibilities are different along and round the axis. In soft iron the former exceeds the latter, whereas in Bessemer steel the circular susceptibility is the greater.

IN the number of the *Nuovo Giornale Botanico Italiano* for November, Sigr. M. A. Mirabella has an interesting paper in which he describes the extra-floral nectaries of various species of *Ficus* cultivated in the Botanic Garden at Palermo. They occur as well-marked nectariferous areas on the young branches or under-side of the leaves. In the same number, Sigr. E. Baroni describes several new species of *Lilium* from China.

THE *Bulletini* of the Italian Botanical Society for October and November contain, in addition to papers addressed especially to Italian botanists, several of more general interest. Prof. G. Cuboni describes a successful attempt to obtain in Italy the very rare germination of the seed of the double cocoa-nut of the Seychelles, *Loidoicea Sechellarum*.—Prof. P. Baccarini has found albuminoid crystalloids in the petals of a considerable number of plants belonging to the Leguminosæ, and especially in fugacious flowers; from which he draws the conclusion that they cannot, in these instances, be regarded as a reserve food-material.—Prof. A. Aloi confirms his previous statement that both terrestrial and atmospheric electricity exercise a very beneficial influence on the growth of plants, and predicts that this may be an important element in the agriculture and horticulture of the future.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 21.—"On the Calibration of the Capillary Electrometer." By George J. Burch, M.A.

In two previous papers the author has described a method of using the capillary electrometer for measuring rapid variations of E.M.F. A sensitised plate, fixed to a balanced pendulum, is carried with uniform velocity past a vertical slit, so that the movements of the meniscus are recorded in a polar curve, in which time is measured by the angular displacement, and the position of the mercury by the radius vector. In such a curve, the total indicated E.M.F. at any instant is the algebraic sum of the P.D. corresponding to the distance through which the meniscus has moved, and the P.D. corresponding to the velocity with which it is moving. In a good instrument the latter is proportional to the subnormal to the curve at that point. The validity of this method depends on the use of an apparatus of which the time-relations correspond to the formula $r = ae^{-c\theta}$, and in the present communication the author describes a practical method of determining the time-constants of a capillary. The first step is the calibration of the scale-readings. This is effected by fixing a glass millimetre scale to the focussing screen, and measuring the E.M.F.s necessary to produce a permanent excursion from the upper limit of the slit to a series of points 5, 10, 15, &c., millimetres lower. For the calibration of the subnormals two normal excursions are photographed with the capillary in the same position. In one the zero is below the field of view, and the movement is directed upwards, and in the other the zero is raised above the field of view, and the potentiometer wires reversed so as to produce a downward excursion.

The object is to obtain two curves in opposite directions running right across the plates, the exact extent and relative position of the excursions being immaterial. The subnormals to these curves are measured at points 5, 10, 15, &c., millimetres from the upper limit of the slit. The author shows that the algebraic difference between the polar subnormals to corresponding points upon two oppositely directed excursions is constant if the time-relations of the instrument agree with the formula $r = ae^{-c\theta}$. With some capillaries the velocity of the meniscus may be different, for the same acting P.D., at different parts of the tube. In such cases the multiplier which turns subnormal readings into volts is proportional to the algebraic difference of the subnormals for any given position of the meniscus. To find the absolute value of this multiplier, a third photograph is taken in which a normal excursion of known value starts from a zero-point within the field of view. The subnormal to this curve is determined for some one of the selected positions, and the corresponding acting P.D. found by subtracting the electrical value of its distance from the zero-line from the P.D. indicated by the potentiometer. The shape of this curve at its origin shows whether the instrument is dead-beat. If the velocity of the meniscus increases after the excursion has begun, the capillary should be rejected. The entire calibration can be completed in about two and a half hours, and the method is applicable to any dead-beat instrument. The author concludes with a criticism of recent papers by Prof. Einthoven on the same subject.

Physical Society, December 13.—Special General Meeting.—Prof. Reinold, Vice-President, in the chair.—The resolution, with reference to the change in the amount of the life-composition fee, passed at the special general meeting held on November 22 last, was confirmed. The ordinary meeting was then held.—Dr. John Shield read a paper on a mechanical device for performing the temperature corrections of barometers. The form of barometer to which the author has adapted his device is that devised by Dr. Colley; it is intended for general laboratory use, and is capable of being read to within 0·1 mm. The barometer tube can be moved in a vertical direction so that the lower meniscus can be adjusted to the zero of the scale. Attached to the barometer tube is a thermometer with a horizontal stem, passing in front of a scale which is fixed to the vertical scale of the barometer. The graduations of this thermometer scale, with the exception of the one passing through the 0° C. mark on the thermometer, are inclined to the vertical, and are so spaced that the reading opposite the end of the mercury column of the thermometer gives directly the correction to be applied to the observed height of the barometer (B_t) in order to obtain the reduced height (B_0). That is, the reading on the thermometer scale gives the value of $B_t(\beta - \gamma)t$ where β and γ are the coefficients of expansion of mercury and of the material of which the barometer scale is composed respectively, and t is the temperature. Mr. Boys admired the simple method the author had adopted for plotting the corrections; and said he always felt that the trouble involved in applying small corrections ought if possible to be avoided, or the correction would often be omitted. Mr. Appleyard advised the placing of the bulb of the thermometer within the barometer tube. Dr. Shield in his reply said as the barometer was only intended to read to 0·1 mm., the placing of the thermometer within the tube did not appear necessary.—A paper by Prof. Rücker, on the existence of vertical earth-air electric currents in the United Kingdom was, in the absence of the author, read by Mr. Kay. In a paper read before the British Association at Oxford, Dr. Schmidt stated that he had expanded the components of the earth's magnetic force in series, and had deduced expressions, two of which give the magnetic potential on the surface of the earth in so far as it depends on (1) internal and (2) external forces. The third series represents that part of the magnetic forces which cannot be expressed in terms of a potential, but must be due to electric currents traversing the earth's surface. Dr. Schmidt concluded that such currents amount on the average to about 0·1 ampere per square kilometre. The author has tested this conclusion, drawn from the state of the earth as a whole, by means of an examination of the line integral of the magnetic force round a re-entrant circuit, taken in the United Kingdom. The necessary data have been obtained from the results of the magnetic surveys for the epochs 1886 and 1891, carried out by the author and Dr. Thorpe. Two circuits called the α and β circuits were selected, having their greatest extension north and south, and east and west respectively. The work done by a unit magnetic pole on traversing these circuits was calculated for the epoch 1886 by means of the terrestrial lines found for that date, and also for the epoch 1891 by means (1) of the same lines when due allowance was made for secular change, and (2) of the independent set of lines found by aid of the 1891 survey. The same calculation was made for a third circuit (γ), using instead of the calculated terrestrial lines the true values of the forces and declinations as deduced from the nearest stations. The following table gives the results in amperes per square kilometre.

	α	β	γ
1886 ...	−0·026 ...	−0·004 ...	—
1891 (1) ...	+0·001 ...	−0·005 ...	—
1891 (2) ...	— ...	— ...	−0·008

From these figures the author concludes that there is not in the United Kingdom, at any rate, a vertical current amounting on the average to 0·1 ampere per square kilometre.—Mr. Watson said a few words on the difficulty experienced in determining the line integral in South Wales due to the presence of closed curves.—The Society then adjourned till January 24, 1896.

Zoological Society, December 3.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the months of October and November 1895, and called attention to the acquisition of a specimen of the wild goat of the island of Giura, in the Ægean Sea (*Capra dorcas*).—Mr. Tegetmeier exhibited a specimen of a crab with a supernumerary claw.—A communication was read from Dr. G. Stewardson Brady, F.R.S., containing a supplementary report on the Crustaceans of the group Myodocopa obtained during the *Challenger* expedition, to which were added notes on other new or imperfectly known species of this group.—Mr. F. E. Beddard, F.R.S., read papers on some points in the anatomy of *Pipa americana* and on the diaphragm and the muscular anatomy of *Xenopus*. The author added remarks on the affinities of these two anomalous Batrachians, which he considered to have been correctly placed together in the system.—Mr. W. Bateson, F.R.S., gave an acount of the colour-variations of a variable beetle of the family Chrysomelidæ (*Gonioctena variabilis*) statistically examined. It was shown that the individuals are chiefly either red spotted with black, or else greenish grey striped with black. All intermediates occurred, but were less common than the type-varieties. These facts illustrated the phenomenon of organic stability.—A communication from Mr. R. Lydekker, F.R.S., contained remarks on the affinities of the so-called extinct Giant Dormouse of Malta. The author stated that this extinct rodent did not belong

to the Myoxidæ, but rather to the Sciuridæ, unless it were necessary to assign it to a family apart. He proposed for its reception the new generic term *Leithia*.—A communication was read from Mr. W. E. Jennings Bramley, giving an account of the mode of capturing Loder's Gazelle (*Gazella loderi*), used by the Arabs of the Western Desert of Egypt.—Mr. G. A. Boulenger gave descriptions of a new snake (*Typlops nigricauda*) and of a new frog (*Chiroleptes dahlii*) from Northern Australia.—A second paper by Mr. Boulenger contained an account of the type-specimen of *Boulengerina stormsi*—an Elapoid Snake from Lake Tanganyka, recently described by M. Dollo.

Geological Society, December 4.—Dr. Henry Woodward, F.R.S., President, in the chair.—On the alteration of certain basic eruptive rocks from Brent Tor, Devon, by Frank Rutley. The author gave a detailed account of the microscopic characters of sections of rocks from Brent Tor, and discussed the history of the rocks, comparing them with Tertiary basic glass, and with the Devonian rocks of Cant Hill, which he described previously. He brought forward evidence in favour of the view that the original alteration of both the Brent Tor and Cant Hill rocks was palagonitic, and that while in the Brent Tor rocks the subsequent alteration of the palagonite into felsitic matter, magnetite, secondary felspar, epidote, and probably kaolin, and some serpentine and chlorite was complete, it was only partial in the case of the Cant Hill rocks.—The Mollusca of the Chalk Rock (part i.), by Henry Woods In the introductory part of the paper, the author gave an account of the characters, distribution, and literature of the Chalk Rock. The main part of the paper was devoted to the consideration of the cephalopoda, gasteropoda, and scaphopoda. Some new species were described, and the synonymy and distribution of the others treated in detail, figures and descriptions being given of the forms not previously well known. The account of the lamellibranchs and the general conclusions were reserved for part ii.

PARIS.

Academy of Sciences, December 9.—M. Marey in the chair.—M. Marey gave an account of his visit to the Royal Society, London, in his official capacity as President, on the occasion of the celebration of the anniversary of the foundation of that Society.—Analysis of aluminium and its alloys, by M. Henri Moissan.—Morphological study of the lymphatic capillaries of Mammifers, by M. L. Ranvier.—Valuation of meals as regards their value for baking purposes; estimation of the waste due to the husk and germ which may lower the quality of the bread, by M. Aimé Girard —On the variations of the ratio of the specific heats of fluids—carbonic acid, by M. E. H. Amagat.—On the analysis of soil by plants, by M. G. Lechartier.—Resistance of straight beams fixed on elastic supports, by M. Paul Toulon.—Application of integral invariants to the reduction to the canonic type of any system of differential equations, by M. G. Kœnigs.—On the number of classes of quadratic forms of negative determinant, by M. Matyas Lerch.—On the varieties of unicursals of three dimensions, by M. Autonne.—On orthogonal systems, by M. E. Goursat.—On the photography of stationary luminous waves, by M. Izarn.—Absorption of nitrogen by lithium in the cold, by M. H. Deslandres.—On a possible process for the separation of argon and atmospheric nitrogen, by M Claudius Limb.—Action of alcohol on mercurous iodide, by M. Maurice François. Boiling alcohol decomposes mercurous iodide. The decomposition ceases when 100 grams of liquid contain, in round numbers, 0·220 grams of mercuric iodide in solution. This action is reversible, and the inverse action stops at the same limit. The quantitative separation of mercurous and mercuric iodides by alcohol is not exact.—New synthesis of parafuchsine and its mono-, di-, tri-, and tetra-alkoyl derivatives, by M. Maurice Prud'homme.—On a mode of decomposition of some organic substances with amide or imide functions, by M. Œchsner de Coninck.—On the approximate limits of the accuracy of the estimation of marsh-gas by means of the platinum- or palladium-thread grisoumeter, by M. J. Coquillion.—On the distribution of boric acid in nature, by M. H. Jay. Boric acid is very widely spread, is absorbed by plants but rejected by the animal economy.—Solubility and activity of soluble ferments in alcoholic liquids, by M. A. Dastre.—Experiments on the "blanc de champignon" obtained by germination in a sterilised medium, by MM. J. Costantin and L. Matruchot.—On the mechanism of muscular contraction, by M. A. Imbert.—Experimental researches on the silent electric discharge, by M. Henry Bordier.—On the constitution and structure of the osseous spine of the dorsal fin in some malacopterygian fishes, by M. Léon Vaillant.—On the metamorphism of the Cambrian of the "Montagne Noire," by M. J. Bergeron.—On the measurement of the intensity of perfumes applied to biological researches, by M. Eugène Mesnard.—Fixation of tannic acid and gallic acid by silk, by M. Léo Vignon.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Euclid's Elements of Geometry: H. M. Taylor (Cambridge University Press).—La Topographie: Prof. P. Moëssard (Paris, Gauthier-Villars).—Beiträge zur Geophysik, 2 Band, 2-4 Heft (Stuttgart, Koch).—Rambles and Studies in Bosnia, Herzegovina, and Dalmatia: Dr. R. Munro (Blackwood).—Lehrbuch der Botanik für Hochschulen, Strasburger, Noll, Schenck and Schimper, Zweite Umgearbeitete Auflage (Jena, Fischer).—Handbuch der Poläarktischen Gross-Schmetterlinge für Forscher und Sammler: Dr. M. Standfuss (Jena, Fischer).—Peru: E. W. Middendorf, 3 Band (Berlin, Oppenheim).—Public Health in European Capitals: Dr. T. M. Legge (Sonnenschein).—Problems in the Use and Adjustment of Engineering Instruments: W. L. Webb (Chapman and Ha l).—Rope Driving: Prof. J. J. Flather (Chapman and Hall).—Elementary Principles of Mechanics: Prof. A J. Du Bois. Vol. 3. Kinetics (Chapman and Hall).—A Treatise on Hydraulics: Prof. H. T. Bovey (Chapman and Hall).—Missouri Geological Survey, Vols. 4 to 7 (Jefferson City).—Smithsonian Institution, Report of the U.S. National Museum, 1893 (Washington).—Geological and Natural History Survey of Minnesota Reports, 1893-4 (Minneapolis).—U.S. Department of Agriculture, Report of the Chief of the Weather Bureau, 1893 (Washington).—Les Cavernes et Leurs Habitants: Prof. J. Fraipont (Paris, Baillière).—Mammals of Land and Sea: Mrs. A. Bell (Philip).—Handbuch der Mineral Chemie: Dr. C. F. Rammelsberg, Zweite Auflage, 1 and 2 Theil, and Ergänzungsheft zur Zweiten Auflage (Leipzig, Engelmann).—Object Lessons for Infants: V. T. Murché, Vol. 1 (Macmillan).—Practical Plane and Solid Geometry: J. Harrison and G. A. Baxandall (Macmillan).—Elementary Mensuration: F. H. Stevens (Macmillan).—British Guiana and its Resources (Philip).—The Physiology of the Carbohydrates: Dr. F. W. Pavy (Churchill).

PAMPHLETS.—Ueber einige Probleme der Physiologie der Fortpflanzung: Prof. G. Klebs (Jena, Fischer).—Grundzüge der Marinen Tiergeographie: Dr. A. E. Ortmann (Jena, Fischer).—Reconnaissance of the Gold Fields of the Southern Appalachians: G. F. Becker (Washington).—Health Notes for the Seaside: A. C. Dutt (Whitby).—Common Sense in Chess: E. Lasker (Bellairs).

SERIALS.—Journal of the Franklin Institute, December (Philadelphia).—American Journal of Science, December (New Haven).—Engineering Magazine, December (Tucker).—Contributions from the U.S. National Herbarium, Vol. 3, No. 4 (Washington).—Proceedings of the Calcutta Academy of Sciences, 2nd series, Vol. v. Part 1 (San Francisco).

CONTENTS. PAGE

THURSDAY, DECEMBER 26, 1895.

THE EVOLUTION OF ART.

Evolution in Art: as illustrated by the Life-histories of Designs. By Alfred C. Haddon, Professor of Zoology, Royal College of Science, Dublin. Pp. xviii + 364. (London: Walter Scott, Limited, 1895.)

THIS little book answers admirably to the idea of the Contemporary Science Series, of which it forms part, in being at once a work of original research and a popularisation of the subject. It is an example of the scientific method as applied to the history of art. That method, as cannot be too often repeated, consists essentially in patient accumulation of facts, and their classification according to their observed connections. The inferences which are drawn, after this process has been gone through, are trustworthy in direct ratio with the accuracy with which the facts have been observed and recorded and the extent of the area over which they have been collected.

The history of art is a most attractive subject; but until the last few years almost every thing written upon it had relation only to the art of very advanced communities, and for the most part only to a small department of that art. Hence little or no light was thrown upon the beginnings of human art; and only within limited provinces was any attempt made to trace its development and decay. The study of anthropology has effected a revolution in this, as in many other departments of thought. We now see that, as Prof. Haddon puts it, "in order to understand civilised art we must study barbaric art, and to elucidate this savage art must be investigated." We must, indeed, go back to the beginnings; or if we cannot literally do this, we must seek the earlier stages of art in circumstances as nearly akin as possible to those which first started it on its career. This is what Prof. Haddon has done. A biologist before he became an anthropologist, he brought to anthropological investigation a trained scientific sense. While on a zoological mission to Torres Straits he came in contact with the natives of the smaller islands, as well as of New Guinea itself, and was impressed with the exceeding interest of the anthropological data offered by tribes of savages as yet little corrupted by civilisation. Having both on the spot and, since his return, in the museums of Europe analysed and compared their artistic productions, he takes the art of this corner of the world as the point of departure for a larger inquiry. His investigations among the natives themselves enable him to speak with authority as to the meaning of their artistic motives, and to add the external witness of the people who produce the works to the internal witness of the works themselves. It was the generic differences between the art of one district in New Guinea and that of another district, which first drew his attention to the subject, and impressed upon him the truth on which he rightly insists that, in order to understand the art of any pattern, type, design, or motive whatever, its life-history must be studied; for every pattern, every type has a life-history, just as every species and every individual in the natural world has a life-history. And for this purpose every pattern and every type must be studied locally; that is to say, if the student be not actually on the spot, he must, in the first instance at least, confine his inquiries within the sphere of prevalence of the particular pattern he is studying, and not wander to different countries where similar patterns are to be found, which may spring from wholly different artistic motives.

Guided by these principles, the author begins by examining the decorative art of British New Guinea, dividing it into five regions, in which five several styles are respectively predominant. Of these, the materials at present available do not admit of a decisive opinion on the origin and motives of the art of the Fly River. The same observation applies to a great extent to the elaborate art of the Central District. In the other cases, the motives are seen to be a representation of some natural form, which becomes in course of frequent repetition degraded, until it assumes patterns where the original form is wholly unrecognisable without having the intermediate stages before the eye. The most interesting of these patterns are derivatives from the human face and from the head of the sacred frigate-bird.

Prof. Haddon then passes to a more general investigation of the material of which decorative patterns are made. He divides it into the decorative transformation and transference of artificial objects, and the decorative transformation of natural objects. In this chapter he is of course largely dependent upon the works of his predecessors; but he is able often to reinforce their conclusions from his own observations. In the following chapter he discusses the reasons which impel men to decorate objects. These he classifies into the æsthetic impulse, or desire for beauty; the desire to give information, including a summary account of the passage of picture-writing into alphabetical signs; the accumulation of wealth, by which objects originally of use, and therefore valuable, became through artistic treatment valueless for practical purposes, while they retained a more or less factitious value as symbols of wealth, and acquired at the same time an æsthetic value in consequence of the pains and skill spent upon them; and lastly, magical and religious motives. In this last section, Prof. Haddon's reputation as a student of folk-lore, or the psychological side of anthropology, gives his opinions great weight; and the conclusions of earlier inquirers, which his cautious reasoning leads him to support, must be regarded as, in the present state of our knowledge, established.

Finally, the author devotes a chapter to a full vindication of the scientific method of studying decorative art, and of his mode of procedure in the present volume. It cannot be said that the arrangement which places this chapter at the end is satisfactory. It would have been more logical to place the argument for the biological treatment of designs at the beginning; and it would, moreover, have saved some repetition, and have given a reader approaching the subject without previous scientific study of art, a preliminary grasp of the method adopted, and of the reasons for its adoption.

It is impossible here to do justice to Prof. Haddon's treatment of his subject. Although, as will be seen from

the foregoing analysis, his attention is mainly concentrated upon decorative art, the reasoning he has employed must apply to other kinds; and, indeed, he shows in the course of the volume many instances of such application. The number and interest of the questions he suggests, forbid discussion in the space at my command. The extent of ground covered necessitates dealing in a summary manner with certain portions of the field. It cannot be helped. In a work of this kind it is more important to give glimpses of results beyond those actually worked out, than it is to establish a number of conclusions in detail. Prof. Haddon is fully alive to this; and while his conclusions, as far as they go, are in the main sound, and his exposition is clear and forcible, to fulfil the more important office he voluntarily foregoes much that would have added interest in the eyes of specialists, and perhaps in the eyes of others also. For he student every page will have its own suggestions. That humbler, but much more formidable, person, the general reader, for whom the book is also intended, if he be unacquainted with the writings of Holmes, Balfour, Dr. Colley March, and Count Goblet d'Alviella, will find himself in a new world. He cannot have a more trustworthy and companionable guide, with whom to commence its exploration, than Prof. Haddon.

Most of the figures are well and clearly reproduced; but a few of them would be greatly improved by the adoption of a larger scale. Some, such as the bamboo-pipes in Fig. 1, and Buddha's footprint in Fig. 130, are almost useless, on account of their diminutive size as compared with the intricacy of their patterns.

E. SIDNEY HARTLAND.

THE FLORA OF BOURBON.

Flore de l'Ile de la Réunion [*Bourbon*] . . . *avec l'Indication des Propriétés Économiques et Industrielles des Plantes*. Par E. Jacob de Cordemoy. (Paris: 1895.)

THE appearance of Dr. Cordemoy's long-promised book on the flora of Bourbon will be welcomed with great satisfaction, as this was the only island of the Mascarene group proper of which the plants had not been worked out in detail. Dr. Cordemoy's work is not compiled on the same lines as the British Colonial Floras, and in some respects compares unfavourably with them; notably in the want of uniformity in treatment, and the absence of particulars of the general distribution of the plants. But the author has laboured under the great disadvantage of being remote from a botanical centre of literature and collections, and has done exceedingly well considering these drawbacks, except that, with his thirty-five years of experience, he might have given a much more interesting account of the vegetation, and a better summary of the facts brought to light by his investigations.

Mauritius and Bourbon, separated by about 100 miles, are nearly of the same extent; but the mountains of the latter rise to an altitude of nearly 9500 feet, or upwards of 6000 feet higher than those of Mauritius. This additional elevation adds a zone of vegetation to Bourbon which is practically unrepresented in Mauritius; yet there is no strictly Alpine element in the flora, and the presence of native species of such genera as *Ranunculus Stellaria*, and *Hypericum* hardly marks a cold climate. Perhaps the most striking thing in the flora of the two islands is the large number of characteristic genera and species common to both. For example, the indigenous palms of Bourbon are: *Hyophorbe indica*, *Dictyosperma alba*, *Acanthophœnix rubra*, *A. crinita*, and *Latania Commersonii*. These are also, all of them, indigenous in Mauritius, and nowhere also. This is a strong contrast to the strictly endemic palm-vegetation of the Seychelles. On the other hand, Bourbon possesses a bamboo, *Nastus borbonicus*, which covers extensive areas at 4250 to 6500 feet, growing to a height of 35 to 50 feet. Excluding *Pandanus utilis*, four species of screw-pine are described; all endemic, and evidently constituting a prominent feature in the landscape, both on the seashore and high up on the mountains.

Other genera and species common and restricted to the two islands are: *Cossignia pinnata* (Sapindaceæ), *Grangeria borbonica* (Rosaceæ), and *Psiloxylon mauritianum* (Lythrarieæ?).

Among characteristic genera largely developed in both islands are *Dombeya* (Malvaceæ), *Quivisia* (Meliaceæ), and the shrubby *Psiadia* (Compositæ). Among mountain shrubs of wide distribution within the African region, *Phylica nitida* and *Agauria salicifolia* are noteworthy. The former Cordemoy describes as a new species, with the remark that it may be the same as *P. mauritiana*. I have elsewhere[1] given my reasons, supported by the opinion of previous writers, for uniting the forms of *Phylica* inhabiting the Tristan da Cunha group, Amsterdam Island, Bourbon, and Mauritius under one species; and a further examination of the specimens does not alter that conviction. *Agauria salicifolia* is a common shrub on the mountains of Mauritius, Madagascar, and Continental Africa, westward to the Cameroons.

The discovery in Bourbon of *Bryodes micrantha* (Scrophularineæ) is interesting. It is a minute plant, only known at Kew from the one small specimen on which the genus was founded, collected in Mauritius by Bojer.

Hydnora africana, a root-parasite, found in some districts of South Africa, is recorded as common at Saint Paul, and as being known under the name of *Rose de Noël*. This is even more remarkable than the discovery of a new species of *Cytinus* in Madagascar.

As in Mauritius, so in Bourbon, gymnosperms are wholly wanting in the native and naturalised flora; and at present only one species each of *Podocarpus* and *Cycas* is known to inhabit Madagascar. They are both endemic. The phyllodineous *Acacia* (*A. heterophylla*), which has lately been recorded as introduced in Madagascar, and which is so near the Sandwich Islands *A. Koa*, as to be hardly distinguishable, if you did not know where your specimens came from, is said to be very common on the mountains, between about 3250 and 6500 feet. It is also common in Mauritius, and apparently undoubtedly native.

With regard to the total number of indigenous species of vascular plants, as compared with that of Mauritius, it is not easy to arrive at a satisfactory estimate, because many of the plants now commonest were probably introduced; but 1000 is, perhaps, below the actual number,

[1] "Botany of the *Challenger* Expedition," i. 2, p. 148.

as against 850 in Mauritius. The larger number may be accounted for by the greater elevation of Bourbon, as well as the divergencies in the numerical representation of the predominating natural orders. Some fourteen fewer natural orders are represented in Bourbon, but, in return, several orders are much more numerously represented.

It was known that Bourbon, as well as Mauritius, was exceedingly rich in ferns and orchids; yet few botanists will be prepared for the fact that orchids outnumber the two next highest orders combined. Orchids are absent or very rare in small remote islands, and comparatively rare in larger ones where there is a humid climate and rich vegetation; or even absent, Juan Fernandez, for example; and British India is the only large continental area, so far as I am aware, in which orchids predominate over any other order. Nearly 20 per cent. of the flowering plants of Bourbon are orchids; the total number described being 172 species, and the author expresses a doubt whether this is exhaustive. Three new genera are proposed, one, *Hemiperis*, comprising twenty-one species. Altogether seventy-two are described as new, and they are about half epiphytic and half terrestrial. Very few of these orchids are represented in the herbaria of this country, and, indeed, many of the other endemic plants of the island, especially the inconspicuous ones.

Dr. Cordemoy describes three or four new genera belonging to other orders, but mostly from somewhat imperfect materials. The most interesting is a labiate (*Mahya stellata*), supposed to be the only really indigenous member of the order, and exceedingly rare, being found only on the summit of the Grand Benard, at about 8500 feet. W. BOTTING HEMSLEY.

TECHNICAL EDUCATION.

The New Technical Educator. Vols v. and vi. (London, Paris, and Melbourne: Cassell and Co., Limited, 1895).

THESE are the concluding volumes of a valuable series of treatises on various technical subjects; the previous ones have already been noted in our columns. All the subjects are dealt with in an admirable manner, the author in each case being a specialist. The arrangement of the work is such that in most cases each volume contains information bearing upon a particular subject. A good index has been placed at the end of the last volume, and this very materially adds to the value of the work.

Prof. W. H. Greenwood's treatment of the manufacture of "Steel and Iron" is excellent. Commencing with the ores, he takes the reader through all the many processes in vogue, with ample illustrations and descriptions. The question of tests, however, appears to be generally overlooked. This is unfortunate, because it is of great importance both to the manufacturer and the engineer. In all modern specifications the quality of the material to be used is always stated, either in the form of mechanical or chemical tests.

Another well-written section is that on "the Steam Engine," by Archibald Sharp. In this case, also, the subject has been thoroughly dealt with from the beginning. The illustrations and descriptions are of recent engines, and boilers. Of the latter, the water-tube type has not been overlooked; more might have been said, however, on the subject. The locomotive is represented by one of Mr. Worsdell's compounds, and we are told that "compound locomotives are being largely used." This statement is scarcely correct, because in this country, at any rate, they are at a discount. The same author has much to say on the subject of "Gas and Oil Engines." He omits to describe the porcelain ignition tubes now largely used in place of iron.

On "Engineering Workshop Practice," by several authors, we find much general information dealing with the engineering trades. Taken as a whole, the treatment flavours more of the amateur than of the tradesman. The same cannot be said of "Electrical Engineering," by Edward A. O'Keeffe, because this subject occupies a prominent position in these volumes, having been particularly well written throughout. The last two volumes treat more particularly of the construction of incandescent lamps, accumulators and measuring instruments, concluding with descriptions of the microphone, telephone and phonograph, besides sundry details.

"Civil Engineering" has also been creditably treated from all points of view, the construction of roads naturally coming much to the front, and the praises of Telford and Macadam duly sung. An interesting account is included on the rise and progress of railways; when discussing probable speeds, we read: "The desire is now for higher speeds, and as much as 250 miles per hour is projected." This statement is far-fetched, and should have been omitted. The table giving train resistances, on p. 175, vol. v., would have been of more value had the authority been quoted. Further on, permanent way is discussed, and we are informed that "sleepers are never placed under the fish-joints." This statement is not correct. Another inaccuracy is found on page 297, where we read "that the driving-wheels of some locomotives have as much as twenty-five tons on them"; even the Great Northern people would probably plead "not guilty" to twenty tons on the driving-wheels of their famous single engines. Much useful information has been brought together under the heads of hydraulics, pumping machinery, lighthouses, ships, &c.

The "Dyeing of Textile Fabrics" is fully discussed, the author being Prof. J. J. Hummel, of the Yorkshire College; treated very much from a chemical point of view, dyers will find much to learn on this subject. In answer to the question, "What is technical education?" we find some sound remarks from the pen of Mr. Henry Cunynghame. He observes that the use of a knowledge of principles, as compared with the mere routine of the workshop, cannot be overrated; this is the distinguishing feature of the true mechanic from the factory hand. Much has been done of late years to encourage the formation of technical schools; but more must be done if we are to retain our present position as a manufacturing country. A knowledge of principles, both mechanical and chemical, is all-important; and these, in conjunction with machinery of the latest design, must surely tell in the race for trade.

The volumes before us will be of much use to those

wishing to study any of the subjects dealt with in this "Encyclopædia of Technical Education." The treatment is thorough, the illustrations numerous, and the printing good. N. J. L.

OUR BOOK SHELF.

A Laboratory Course in Experimental Physics. By W. J. Loudon, B.A., Demonstrator in Physics in the University of Toronto, and J. C. McLennan, B.A., Assistant Demonstrator in Physics in the University of Toronto. Pp. vi + 302. (New York and London: Macmillan and Co., 1895.)

THIS book, the authors tell us in the preface, is the outcome of their own experience, and is intended, in the first instance, to be used by the students at the University of Toronto, and the hope is expressed that it will be appreciated by those engaged in teaching experimental physics elsewhere.

The book is divided into two parts. Part i. is devoted to the description of elementary apparatus and elementary methods of performing simple experiments in mechanics, light, photometry, and heat. In this part students are only expected to be acquainted with the elements of algebra and trigonometry. On p. 55 is given a very neat elementary proof of the fact that the deviation of a ray of light passing through a prism is a minimum when its direction is symmetrical with respect to the refracting surfaces. We think that, considering how elementary this part is, the explanations might at times be simpler. It is not wise to indulge too frequently in such expressions as "it can be readily seen," even in matter intended for advanced students; and teachers cannot be too lucid when dealing with beginners.

Part ii. is intended for advanced students, and contains directions for experiments in acoustics, heat, electricity, and magnetism, with an appendix on the determination of gravity and on the torsion pendulum. The theory of the various experiments is given, and demands a wider mathematical knowledge, *e.g.* the laws of the transverse vibrations of strings are deduced from the equations of motion. A striking omission in this part is the little attention which is given to the corrections which have to be applied when making most accurate physical measurements.

The choice of experiments is good, the theory and descriptions of the apparatus are accurate, and the illustrations are clear. The division into elementary and advanced is not apt, as many of the experiments in Part ii. would be more suitably placed in Part i. This, however, is not a serious defect, as teachers using the book can arrange the order of the experiments to suit themselves. We certainly think that students of physics should become acquainted with the simpler electrical experiments as early as possible.

The book is well got up, and its value is greatly enhanced by the tables of physical constants at the end. We heartily recommend the work to teachers of practical physics as containing very good matter, and being accurate and free from misprints. W. G. RHODES.

The Natural History of "Eristalis tenax," or the Drone-fly. By G. B. Buckton, F.R.S. Pp. iv + 92. With illustrations. (London: Macmillan and Co., 1895.)

THE author's solid contributions to more than one branch of science may well protect him from criticism of extreme severity, but it is our duty to remark that this is not an adequate account of the drone-fly. The subject is a particularly good one. The drone-fly is very common, large for a dipterous insect, and distinguished by many interesting peculiarities of structure and habit. But the author has not realised how much work goes to the production of an exact and thorough monograph. Such a monograph demands minute investigation of the anatomy of every stage, comparison with some few allies at least, and much patient observation of the living insect. Mr. Buckton has not worked out the anatomy of the drone-fly in any stage, as the vague figures testify. Some important and very peculiar features of the larva are passed over without mention. There is no effective comparison with other insects. The habits of the larva and the fly have been attended to, and the account of the mode of life of the fly contains the only valuable facts in the book. There is much matter concerning insects in general, but this is not always either trustworthy or pertinent. Sometimes facts and theories are cited, not from the original memoirs, but from any author who happened to be at hand. Weismann on *Corethra* is quoted from Balfour, Johnston on *Culex* from Riley, Müller on mosaic vision from Mallock. The danger of this practice is illustrated by the last case, where Mr. Buckton shows that he is not fully possessed of the theory of mosaic vision. It may be useful to remark that the larvæ and egg-chains mentioned on page 19 probably belong to the very familiar *Chironomus*. The drone-fly has been studied by our author as a hobby, and he has no doubt got much pleasure out of it; but a more serious attack should be made upon it before long. L. C. M.

Working Models for Engineering Students. Engine Slide-Valves. Designed by Messrs. T. Jones, M.I.Mech.E., and T. G. Jones, B.Sc. Second edition. (Manchester: John Heywood, 1895.)

TO obtain a thorough insight into the movements of slide-valves, and to completely understand the distribution of steam, is generally a difficult matter to first-year students and engineering apprentices. These models, however, should greatly assist all who study the subject; they are neatly printed on cardboard, the important parts are sectioned and tinted, and the valves are movable so as to show their positions when the piston is at any part of the stroke. The relative positions of crank-pins and eccentrics are clearly shown, as well as the valves and steam-ports. The models are of a convenient size, being six inches long by four inches wide, and they represent eight different kinds of slide-valves. As such models must be absolutely accurate from a mechanical point of view to be of use to technical students, we must point out that No. 1 is said to represent a slide-valve common in locomotive practice; but the valve spindle is shown passing through the valve, whereas valve buckles are always used. No. 2 is a single-acting piston valve for a steam hammer. If it is considered necessary in this case to show the piston and rod, why not do it accurately? The parts shown do not represent a steam-hammer piston and part of the rod.

Model No. 5 represents a partly-balanced ordinary slide-valve. The authors omit to say that the space inside the relief ring must be open to the exhaust cavity to allow any steam leaking past the ring to escape, otherwise it would be of no good. This type of valve is now being largely used for locomotive purposes. The same defect is to be found in model No. 7.

Taken as a whole, the models are very useful for the purpose of illustration; they will be of much value to students and others interested in the subject.

Macmillan's Geography Readers. Book vii. Pp. 240. (London: Macmillan and Co., 1895).

IN this little Reader for elementary schools, instructive descriptions are given of the chief places and objects of interest to be seen in a journey through the United States; and the main historical facts concerning the New World are woven into the lessons, to give them additional brightness. The book also contains sections on ocean currents and tides, and is well illustrated; while the numerous extracts from the writings of travellers, give a good idea of the conditions and characteristics of American people.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Bury St. Edmunds Human Skull Fragment.

IN 1884 the late Mr. Henry Prigg, of Bury, exhibited before the Anthropological Institute a portion of a human skull supposed to be of Palæolithic age. The paper was printed, with an illustration from my pencil, in the *Journal* of the Anthropologica Institute, vol. xiv. p. 51. The relic was found in 1882, in the parish of Westley, in brick-earth at a depth of 7½ feet. Mr. Prigg was in the pit on the morning after the discovery, and could see no traces of a grave, or old disturbance. A few yards from the pit mentioned, a workman reported the discovery of an entire human skeleton in the brick-earth, at a depth of 8 feet, some thirty years previously.

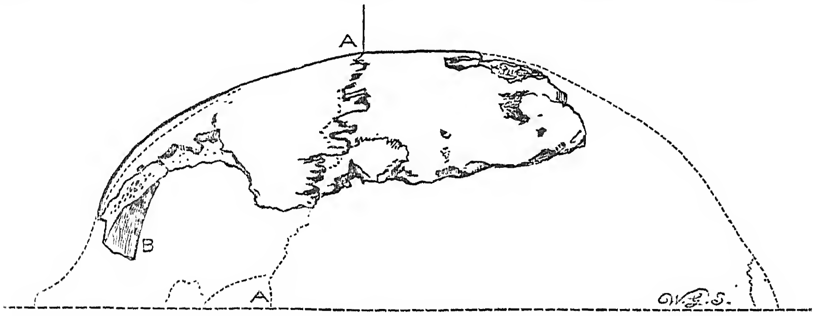


FIG. 1.—View of left side of the Bury skull fragment placed over the contou of Spy skull No. 2. Half natura size

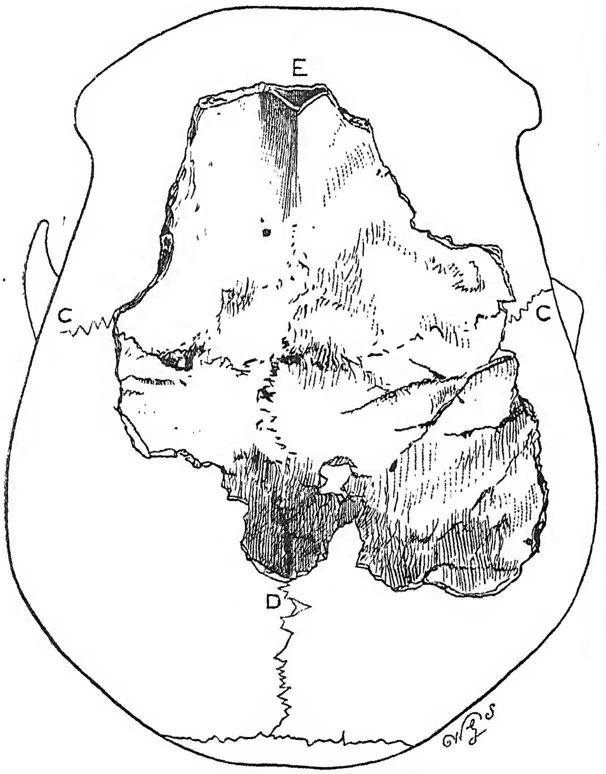


FIG. 2.—Inferior surface of Bury skull fragment placed over the sutures of Spy skull No. 2. Half natural size.

Mr. Prigg in his paper gives the briefest possible description of the skull fragment, which consists of a considerable part of a frontal bone with five inches of the coronal and a little over two inches of the sagittal sutures, and an anterior third of the left parietal bone, and a small anterior portion of the right. At the time when Mr. Prigg's paper was read, the Spy crania had not been discovered.

When the Bury fragment was in my possession in 1884, for illustration, I carefully drew not only the plate published, but the left side and inferior surface. These two illustrations have remained in my possession, and are now photographically reproduced for the first time to one-half the natural size.

The coronal suture is very clearly seen in the left side view (Fig. 1, A A). The upper A shows the point of junction of the coronal with the sagittal. This point is also well marked in the Spy skull No. 2, as well as the line of descent to the lower A. If the point of junction of the two sutures is taken as a fixed position, the close agreement of the line of descent of the sutures and the contour of the two skulls is remarkable. The Bury contour and suture is shown by solid lines, and the contour and suture of the Spy skull by dotted lines. The point B shows the inner plate of the frontal sinus, and indicates the near position of the ophyron and supraorbital prominences on the outer plate.

A comparison of the inner surface of the Bury fragment is equally confirmatory of its affinity with the Spy form. In Fig. 2, the junction of the coronal with the sagittal suture is again used as a fixed point, and the line of the coronal at C C is determined by the line of the sagittal at D. It will be seen by the illustration that the course of the coronal towards the right and left temporal bones is identical in the two examples. Part of the glabella showing the two plates of bone and air chamber is shown at E.

The mere identity of the course of the sutures is not of much importance; but the interesting point is, that when the sutures are taken as fixed guides for putting the Bury fragment in a natural position, the Spy contour results.

Dunstable. WORTHINGTON G. SMITH.

The Coronal Rays of Passion-flowers.

THE filaments, or rays, forming the corona of Passion-flowers are structures of much interest. In 1790, Sowerby described them in *Passiflora cærulea* as a "double row of horizontal, thread-like, radiated nectaries." His subsequent remarks, however, do not assure us that he regarded them as glandular, or as nectaries as we now define them. In Dr. Masters' "Contributions to the Natural History of the Passifloraceæ" (*Trans. Linn. Soc.* xvii.) no mention is made of distinct glandular structure, but Morren's opinion is quoted that "the corona is the seat of the perfume of the flower in *Passiflora quadrangularis*—a fact which he considers proved by the anatomical structure of the coronal threads, as also by the circumstance that if the processes in question be early removed the flowers remain scentless. In repeating this experiment, however," continues Dr. Masters, "I have not been able to satisfy myself of the absolute correctness of this statement. . . . Prof. Morren attributes to the conical pimple-like cells of the epidermis of the coronal filaments the formation of the odoriferous principle. These peculiar cells are found on the surface of the petals, and in the nectariferous portion of the tube of the flower. . . . We must await further evidence before we assume that in the Passion-flowers these cells really secrete the odorant principle." In Vines' "Students' Text-book," recently published, an emphatic statement is made that the coronal rays "are not glandular."

I have not yet had opportunity of studying *P. quadrangularis*, but a strongly and rather pleasantly scented hybrid, named *P. Buonapartea*, the parentage of which is stated to be *P. alata* × *P. quadrangularis*, has been under careful observation. In it the rays bear an apical tuft of glands, visible to the naked eye as a whitish knob. When magnified the glands are multicellular, relatively large, and in form remind one of those found in *Rubiaceæ*. The rays of the common *P. cærulea* are devoid of

apical glands, and the odour of the flower is rather weak, and very disagreeable. In a cross of my own raising, the parentage being *P. Buonapartea* × *P. cærulea*, the flower is delightfully odoriferous, and the rays are tipped with glands, about half as well developed as those of the former (the seed) parent. That such is the case points to the possibility of the terminal cells of the rays of such as *P. cærulea* being glandular in function in some degree. The general structure of the ray is the same in all, in respect of having conical epidermal cells, spiral vessels running up to the apex, and bearing, besides numerous conglomerate crystals, so great a number of minute starch granules as to render portions often almost black when treated with iodine.

It was repeatedly proved that the perfume of my variety was located in the rays—presumably the apices. It is singular that certain hybrids studied, stated to be between *P. alata* and *P. cærulea*, *e.g. Impératrice Eugénie*, do not bear any coronal glands, for it seems likely from analogy (flowers not yet having been observed) that *P. alata* should possess them; one being tempted to assume that species with long filaments at about right angles to the corolla will be found to bear glands, while those with shorter ones, lying at a small angle with the corolla, will not.

JOHN H. WILSON.

Yorkshire College, December 12.

Colours of Mother-o'-Pearl.

IN your issue of October 24, Mr. C. E. Benham calls attention to the fact that the colours of mother-o'-pearl cannot be due to the striations on the surface, as originally explained by Brewster. I have recently communicated a paper to the *Geological Magazine*, June 1895, in which I came to the same conclusion, and also found it impossible to accept the lamina theory as stated by Mr. Benham, for the following reasons. In certain fossilised shells, notably those of the Ammonites, the conchiolin of the shell has in course of time disappeared, and there remains not the lamina, but the prismatic structure; hence I concluded that the latter was the fundamental form in which the calcite of the shell was deposited. In *Am. Ibex*, *Elisabethæ*, &c., the shell has a chalky appearance, consisting of the detached prisms which can easily be separated by rubbing; but when the shell is carefully soaked in Canada Balsam the interspaces become filled up with the resin as they were in life, and the play of colours is perfectly reproduced. Where the original calcite has been replaced by some other mineral, such as silica or marcasite, as exemplified in the Blackdown and Gault Ammonites, it is not the lamina, but the prismatic structure that is reproduced, and in both cases the play of colours is similar to that of the original shell. In Meleagrina, whence the ordinary mother-o'-pearl is derived, the prisms of the shell are not so regular as those in the Ammonites, but the cause of the colour is the same. The laminæ of shell material, though very thin, are hardly thin enough to produce the phenomenon as Mr. Benham would have it. A full description of these prisms, and the way they affect light, is given in the paper above referred to.

ERNEST H. L. SCHWARZ.

Cape Town, November 14.

I AM indebted to you for giving me the opportunity of a remark on Mr. Schwarz's letter. Interesting and valuable though his researches were, the argument, as stated in the paper to which he refers, did not carry conviction to me. To deduce from fossils, in which secondary changes of mineralisation have admittedly taken place, conclusions as to the minute histology of recent shells, seems precarious. The connection between the prisms and the experimentally produced iridescence is not clearly proved; and the explanation of the supposed connection is based on a purely hypothetical arrangement of calcite crystals, such as mineralogists consider highly improbable. It is not proved that the iridescence experimentally produced in the fossils is the same as that occurring in a recent shell. As for Mr. Schwarz's new objection, that the laminæ are not thin enough to produce the phenomenon, this is certainly true for the calcite laminæ, and is equally fatal to Mr. Schwarz's own explanation; but some of the conchiolin laminæ are far thinner than the calcite, and might well produce interference in the light reflected from their upper and under surfaces.

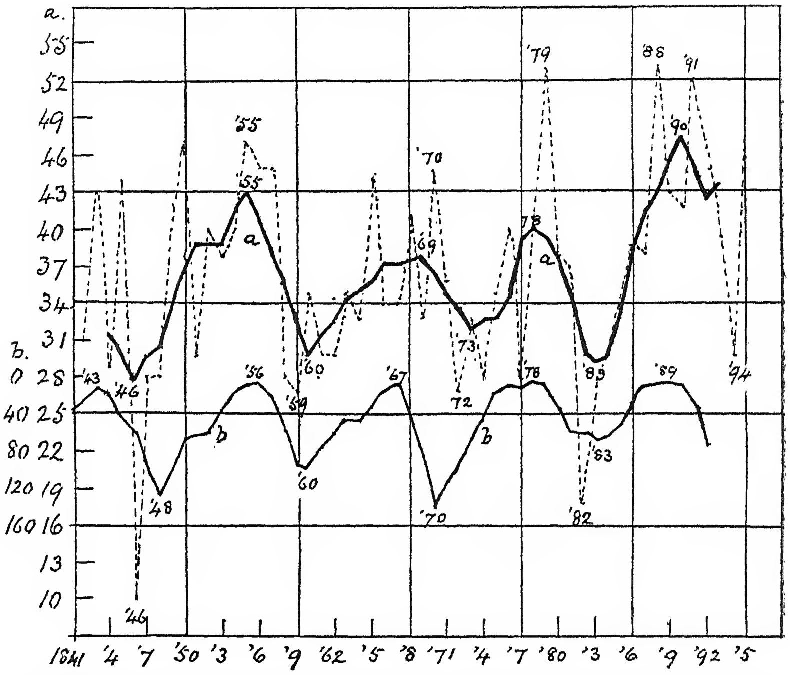
F. A. BATHER.

December 12.

Northerly Wind in Winter Seasons.

THE recent variations of northerly wind at Greenwich in a series of the cold seasons October to March (the winds being reduced to the four cardinal points) present some interesting features, to which I would invite attention.

These variations, since 1841, are exhibited in the dotted curve of the diagram (the ordinate figures expressing days); and a smoothing process having been applied (averages of five), we have the continuous curve (*a*). It will be observed that the four long waves brought out more clearly by this smoothed curve show a good deal of correspondence with those of the sunspot cycle, an *inverted* curve of which is given below (*b*). The higher values of northerly wind seem to be more frequent, on the whole, near sunspot minima, and the lower near maxima. Does this point to a causal relation?



(*a*) Dotted curve, variation in number of days of northerly wind, at Greenwich, in winter half (Oct., March); continuous curve, smoothed with averages of five. (Here 1855, *e.g.*, means Oct.-March 1845-5-&c.)
(*b*) Sunspot curve (inverted).

A few figures may be given. (For brevity we may designate each cold season by the year in which it *ends*; thus 1855 means October-March 1854-55).

We find sunspot minima in

	1856	1867	1878	1889

and maxima of the wind curves as follows:—

Unsmoothed curve	1855 (47)	1870 (45)	1879 (53)	1888 (53)
Smoothed curve	1855 (43·0)	1869 (37·8)	1878 (40·0)	1890 (47·4)

On the other hand we find sunspot maxima in

1848	1860	870	1883	1893

and minima of the wind curves in

Unsmoothed curve	1846 (10)	1859 (27)	1872 (27)	1882 (18)	1894 (?) (30)
Smoothed curve	1846 (27·8)	1860 (30·0)	1873 (31·8)	1883 (29·4)	

The high value for our last cold season strikes one as a little anomalous, causing an unusual break in the smoothed curve, if we suppose (as we perhaps may) that this curve has not yet reached its lowest point before rising to the next maximum (say) about 1901.

It would appear, then, that in the period considered, the northerly type of weather, in which we are generally on the eastern border of an anticyclone, has been specially prevalent about the time of minimum sunspots, giving way to some other type or types in the interval.

A careful study of the behaviour (movements of translation, of contraction and expansion, &c.) of those high and low pressure systems which determine the direction of wind, and furnish our weather generally, seems likely, in the future, to throw some useful light on the nature of solar influence on our atmosphere. In this connection, I may refer to the work of the American meteorologist, Prof. Bigelow, who finds (*Am. Journal of Science*, vol. xlviii. p. 445), that in North America, "the North Low [pressure] and the South High [pressure] belts vary in latitude directly with the solar intensity, being further north at the maximum, and further south at the minimum of the period; while the North High and the South Low belts vary inversely, that is, are further south during the maximum of sunspots."

We know that northerly wind generally means cold, and it would be interesting to trace the effects of the apparently cyclical variation in those winds, above indicated, on health and other matters.

A. B. M.

"Perlites."

Now that attention has been called in NATURE (December 12, 1895, p. 135) to two papers, by Mr. Watts and Mr. Smeeth respectively, in which perlitic structure is examined with much careful detail, may I protest at once against the use made of the word "perlite" by these authors and by the writer of the note in NATURE? So many terms ("granophyre," "picrite," "granulite," &c.) have been already strained by petrographers from their original meanings, that the fine old rock-name "perlite" may also be in danger. It was invented by Beudant in 1822 ("Voyage en Hongrie," tome i. p. 329), as a translation of the German *Perlstein*, and is the name of a glassy rock having a particular structure. It cannot be also used for the globules or cracks which characterise that structure.

GRENVILLE A. J. COLE.

Royal College of Science for Ireland, Dublin, December 13.

The Discovery of the Anti-Toxin of Snake-Poison.

No one has accused Prof. Fraser of claiming priority for his results published in June 1895 over those of Calmette published in May 1894, and over those published by the same investigator in April 1895. Such a proceeding on Prof. Fraser's part would indeed have been rash.

What I have drawn attention to is that when publishing a detailed account of experiments identical with those already published by Calmette, and when drawing conclusions from them similar to those already formulated by Calmette, he omitted to refer to Calmette's published work *in such a way* as to fairly direct attention to the fact that he (Fraser) had been completely anticipated by the French observer. I showed that this had led other persons not conversant with the progress of this branch of scientific inquiry to claim for Prof. Fraser the priority which it would certainly have been unwise for him to have claimed for himself.

I supposed that Prof. Fraser would have been glad of the opportunity of expressing regret for his omission—regret which others must feel though he apparently does not. The theory put forward by Prof. Fraser that it is not usual in communications to the Proceedings of a scientific society *extending to twenty-seven pages octavo in length*, to give more than the very briefest allusion to the latest work on the subject carried out and published by another worker and anticipating all that you have to say, is not, I think, admissible. Especially, it seems to me, is it unusual that the reference to an immediate predecessor's work should be so brief as to appear contemptuous, and so expressed as to be actually misleading (even when read by experts) in regard to the total absence of novelty in the experiments and conclusions which you are about to record as your own work.

Prof. Fraser read one paper to the Royal Society of Edinburgh on June 3, and a second on the same subject on July 15. It is impossible to imagine how many such preliminary statements Prof. Fraser would consider it right to publish, and how long a time he would allow to lapse before making the statement which one would have thought should have been preliminary to them all, viz. that the experiments have been already made, and the results published by Calmette.

London, December 22. E. RAY LANKESTER.

Male of Apus.

THE male individuals of *Apus cancriformis* are so rare, that it appears worth while recording the occurrence of one amongst the specimens used in the Zoological Laboratory in Oxford, during the ordinary course of our work. As Kozubowski showed in 1857, the only external sexual difference is the absence in the male of the egg-sac on the sixteenth appendage, known as the oostegopod of the female. This limb in the male is quite similar to its neighbours: there are no appendages modified for holding the female, such as occur in the allied form, *Branchipus*. It is generally stated that the male of *A. cancriformis* is about one-third the size of the female; whilst Lubbock found that the male of *Lepidurus productus* is larger than the female. The present male did not differ in size from the females; some of which were slightly larger, others smaller.

Oxford, December 18. W. B. BENHAM.

The Merjelen Lake.

IT may help Dr. Du Riche Preller to a precise knowledge of the condition of the Merjelen See, prior to the last *débâcle*, to inform him that on August 3 of the present year the water-level was about 60 feet below the strand-line marking the level of the col by which the lake drained into the Viesch valley. There was at that time an upper as well as a lower lake.

I have a number of photographs which show different aspects of the lake, and I do not doubt but that fairly accurate determinations of the water-level could be obtained from them.

PERCY F. KENDALL.

The Yorkshire College, Leeds, December 17.

THE PARIS ACADEMY OF SCIENCES AND THE ROYAL SOCIETY.

AT the recent anniversary meeting of the Royal Society, M. Marey, the President of the Paris Academy of Sciences, attended in his official capacity. Upon returning to France, he gave an account of his visit, and his remarks are reported in full in the *Comptes rendus* of the meeting of the Academy on December 9. The pleasant relations that exist between the Royal Society and the Paris Academy furnish standing evidence of the truth that the interests of science are international, and M. Marey's remarks on the work in connection with the Catalogue of Scientific Papers show how closely those who are devoted to the advancement of scientific knowledge are bound together. His visit is the visible sign of the kindred feeling which prevails among French and British men of science. In October last, many of our leading workers in science, art, and literature were the honoured guests of the Institute of France, and we may regard the return visit of the President of the Academy of Sciences to the Royal Society as an official expression of appreciation. It is on this account, and because the visit was a matter of unique consequence, that we print literally M. Marey's address to the Paris Academy.

"Je dois rendre compte à l'Académie, des résultats d'une mission que je viens de remplir en Angleterre. La Société Royale de Londres m'avait invité, à titre de Président en exercice de votre Compagnie, à assister aux fêtes anniversaires de sa fondation.

"C'est donc à notre Académie que s'adressait l'accueil si honorable qui m'a été fait à Londres. J'y ai entendu le Prési-

dent sortant, Lord Kelvin, et le nouveau Président, Sir J. Lister, exprimer les liens d'estime, de reconnaissance et d'amitié qui les attachent aux savants français. Dans presque tous les discours qui ont été prononcés, des paroles émues témoignaient de l'admiration que nos voisins professent pour notre regretté Pasteur.

"Je crois avoir été le fidèle interprète des sentiments qui nous animent tous en assurant les membres de la Société Royale de notre estime et de notre sympathie et en rappelant combien nous avons été touchés de l'empressement avec lequel nos Confrères et nos Correspondants anglais sont venus célébrer les fêtes du Centenaire de l'Institut de France.

"Un autre motif encore m'avait valu l'honneur d'être invité par la Société Royale. Cette savante Compagnie entreprend un travail d'une haute importance pour la Science ; il s'agit de la création d'un grand Catalogue international, rassemblant tous les travaux publiés chaque année dans le monde entier sur toutes les branches de la Science.

"La plupart de nos Confrères connaissent déjà le magnifique Ouvrage dans lequel la Société Royale a rassemblé, sous le nom de chaque auteur, les titres des travaux publiés en tous pays depuis l'année 1800 jusqu'à nos jours. Chacun peut trouver, dans ce Recueil, la série de ses propres publications : Livres, Mémoires et jusqu'aux moindres Notes y sont classés par ordre chronologique, avec indication précise du titre et de la date de leur impression. Mais un tel Recueil, excellent lorsqu'il s'agit de retrouver les travaux successifs d'un auteur, se prête mal aux recherches bibliographiques sur un sujet donné. C'est pour combler cette lacune que la Société Royale veut entreprendre l'œuvre colossale dont je viens de parler.

"Déjà beaucoup d'entre nous ont été pressentis relativement à l'opportunité d'un tel travail, et c'est sur l'avis favorable de notre Compagnie que la Société Royale a résolu de faire adresser diplomatiquement à tous les Gouvernements la demande de désigner des délégués pour une Conférence internationale, destinée à rechercher les meilleurs moyens de réaliser cette publication. Jusqu'ici, les réunions du Comité du Catalogue de la Société Royale n'ont été que préparatoires ; il semble toutefois que, sur certains points, l'accord doive être unanime. Il faut, par exemple, que le titre de chaque travail en indique aussi explicitement que possible la nature et les conclusions ; il faut que les titres de certaines Notes se répètent en différents points du répertoire, lorsqu'elles se rattachent naturellement à plusieurs sections du Catalogue. Sur tous ces points, et sur bien d'autres encore, la Commission internationale devra statuer.

"L'importance de l'entreprise ne paraît pas discutable, le nombre toujours croissant des publications scientifiques rend aujourd'hui presque impossible la connaissance des travaux effectués sur un sujet donné ; les revendications de priorité occupent, dans les Ouvrages scientifiques, une place excessive, et beaucoup de savants dépensent en pure perte des mois et des années pour avoir ignoré des travaux antérieurs sur l'objet de leurs études.

"La question est du reste à l'ordre du jour ; plusieurs Sociétés savantes ont déjà des Catalogues très complets, d'autres sont moins bien partagées, mais peuvent déjà fournir de précieux éléments pour le travail d'ensemble. L'Amérique, la Belgique, la France et plusieurs autres nations ont dernièrement réalisé de grands progrès dans la manière de cataloguer les publications scientifiques. On peut donc espérer que, si l'action diplomatique est assez prompte, les délégués des différentes nations pourront se mettre à l'œuvre dès l'année prochaine et feront concentrer pour un travail commun toutes les forces éparses aujourd'hui.

"Dans l'esprit de la Société Royale, les dernières années de ce siècle seraient consacrées à introduire, dans le classement des documents scientifiques, tous les perfectionnements que l'expérience montrera nécessaires, afin que, dès l'an 1901, l'œuvre puisse se poursuivre régulièrement dans sa forme définitive.

"Tels sont les points qui ont été discutés dans la séance du Comité à laquelle j'ai eu l'honneur d'assister et que je me suis chargé de vous transmettre officieusement, en attendant que notre Compagnie en soit saisie d'une manière officielle."

THE HABITS OF THE CUCKOO.

IN an interesting and very valuable series of papers, published in the *Journal für Ornithologie*, and the *Ornith. Monatschrift*, Dr. E. Reh records his latest observations on the parasitic habits of the common cuckoo, which seem to entirely confirm what he has already given us in his larger work, "Altes und Neues aus dem Haushalte des Kuckucks."

In 1893, not more than two kilometres from Leipzig, no less than 70 nests were found containing cuckoo eggs ; of which, 58 (83 per cent.) were in nests of the Red-backed Shrike (*Lanius collurio*).

In this year it was observed that five females were missing, while at the same time eight females were detected as new to the locality. Four new foster-parents were also noted. An approximate balance is thus preserved. Fresh arrivals are recognised by means of their eggs ; for Dr. Reh finds that the colouration of the egg of every female is peculiar to itself, and constant. Each cuckoo returns every year to the same locality, and lays its eggs only in the nests of that particular species which it, or its ancestors, happen to have adopted for that purpose. Thus, not only can every egg in a district be identified, but the number laid by any given female can be determined with a tolerable degree of accuracy.

This yearly census of the cuckoo population seems to show that the young do not return to their birthplace to breed ; or that, if they return, they do not succeed in laying eggs, being driven away by the parent birds. The evidence for this view is based partly on the fact that the numbers remain approximately fixed for each locality, and partly on the assumption that the egg of the daughter cuckoo would be similar to, but not exactly like that of the parent. It has been found, however, that the eggs which are presumably new to a locality are of types totally distinct from the types of eggs laid by birds which, so to speak, belong to the neighbourhood.

Cuckoos would seem to be more prolific than is generally supposed, an egg being deposited on alternate days from the middle of May to the middle of July. Occasionally it happens that an egg is laid every day for a short period, but such an occurrence is rare. Sometimes two eggs are found in the same nest. Such cases can always be referred to particular birds which seem to have a tendency to colonise, as is the case with an American ally, *Crotophaga*.

It is related that on one occasion a male cuckoo was seen leaving a shrike's nest, noisily calling the while, and pursued by one of the infuriated owners—whether male or female could not be determined—until at length both were lost to view. The whole proceeding produced the impression that the male had purposely provoked the chase in order to give the female time to deposit its egg. When the shrike returned it was accompanied by its mate. On the previous day this nest had been found empty ; at 3 p.m. on the afternoon on which the chase occurred it contained one shrike's egg ; on a third inspection it was observed that a cuckoo's egg had been added.

As an additional piece of evidence in support of the contention that the cuckoo first deposits its egg on the ground and thence carries it to the selected nest, Dr. Reh quotes a case in which a cuckoo's egg was found smeared with red earth similar to that which occurred in the immediate vicinity of the nest from which this egg was taken.

As is well known, cuckoos' eggs found in the nests of some species of host differ widely one from another in colouration, while those from the nests of certain other species show a great similarity amongst themselves. Dr. Reh points out further that precisely the same features obtain among the species with which these eggs are found. Thus cuckoos' eggs from nests of the red-backed shrike show a wide dissimilarity in colouration, but not more so than do those of the shrikes themselves ; but, on the other hand, cuckoos' eggs from the nests of the wren exhibit great uniformity of colouration, just as do those of the host. As an explanation of these facts, it is suggested that this variability is due to the nature of the food upon

which the young birds are reared; in the case of the shrike the diet is of a mixed nature, but is fairly uniform in the case of the wren. To secure a foundation for this theory it is assumed that cuckoos, when about to deposit their eggs, intuitively select the nests of the species by which they themselves were reared. Thus it has come about that each particular species of host rears the young of a particular race of cuckoo, the eggs of which, like those of the host, exhibit great variability when the food during the nesting period is mixed, and great uniformity when the food is uniform.

These papers are based upon a great number of observations, which are exhaustively analysed and tabulated for the benefit of those who may be fond of statistics.

THE YORKSHIRE GYPSEY-SPRINGS.

TEN miles to westward of Bridlington Quay, in Yorkshire, is the much-neglected village of Wold Newton, situated, as the name indicates, among the Wolds. It is noted as being the place where the great Yorkshire aerolite—exhibited in the British Museum—fell on December 13, 1795, but more chiefly as being the birthplace of several phenomenal springs known as gypsies (the initial letter "g" pronounced hard). The gypsies of Yorkshire resemble the nailbournes of Kent.

They are variable and intermittent springs of very clear and cold water, and appear on the surface of the chalk valleys. So freely do the calcareous wolds absorb rain, that they will allow it to pass underground as far as the blue gault on which the chalk rests. Consequently, there is scarcely a permanent surface-stream in any of the numerous hollows that lacerate the chalk-hills. The gypsies simply make their appearance in winter, or early spring, or at other periods after heavy rains, when the chalk is saturated. They will sometimes flow for two or three months, then suddenly cease, leaving scarcely a mark upon their birthplaces. They have been known to have been quite inactive for three consecutive years. The emission is often so copious as to constitute a very considerable stream, filling a drain twelve feet wide and three feet deep. This is called the gypsey-race, and it conveys the flushed tide through the villages of Burton Fleming, Rudstone, Boynton, and finally disembogues it through Bridlington harbour into the sea.

The principal gypsey-head is in a field on the left side of the road between Wold Newton and Foxholes. Another gypsey rises to the light at Kilham, seven miles away. It happened fortunate that a native of Wold Newton and I caught the springs all open last Eastertide. We trod over a deal of spongy grass-land to pursue inquiries at the gypsey-head, and were rewarded by finding water issuing through the grass where the ground was not broken, and elsewhere rushing with considerable force over the surface to the height of our boot-tops. Every one of these little eruptions contributes to the race, and by it gets eventually to the sea.

At the western extremity of the great west to east valley of the Wolds—through which ran the old Bridlington and Malton high-road—there is a spring in a bank about a furlong or two east of Wharram-le-Street. This is the fountain-head of the Wold Beck—once known locally as "Lord Carlisle's River"—which travels for some nine miles past the doors of Duggleby, Kirby Grindalythe, West and East Lutton, Helperthorpe, and Weaverthorpe (a street of valley villages). This beck gradually sinks, and finally disappears below the surface before it reaches Butterwick, its sub-surface course being lengthened or shortened as wetness or drought prevails. Some say this beck next reappears at Rudstone; but, in any case, it no doubt feeds the gypsey-head near Wold Newton when the surrounding chalk is all well saturated with rain.

The race has been known dry for three consecutive years, while once or twice it has carried two or three feet of water in mid-August. On Christmas Day, about twenty years ago, it caused the village of Burton Fleming to be flooded, and a farmer I spoke to there said he went about wet-shod for a couple of months owing to this inundation. The gypsies originally shaped a channel for themselves. An attempt to divert this at Burton Fleming proved a failure, so a broad and deep drain of the dimensions already given was cut right away to the sea, and called the gypsey-race. When in flood, it looks like a pellucid trout-stream—twelve-pound trout have been killed on its banks; but there are no fish in it now, and the bed is for miles covered with long emeraldine grass, rippling like tangles of naïads' hair along the swift current. The grass hides the chalk and every pebble; there is no babbling sound; all Yorkshire besides has no stream purer.

Only a century or two ago there were still surviving, from the days of monasteries, many silly superstitions and traditions then attached to the mysterious conduct of the gypsies. In an old tour, said to be written by Defoe, we read that "whensoever those gypsies—or, as some call them, vipsies—break out, there will certainly ensue famine or plague." In fact, as the overflowing of the Nile was to the ancients long an enigma, so was the rising of the gypsies, and may be yet so, even to some of the learned. HARWOOD BRIERLEY.

NOTES.

PROF. SYLVESTER has been elected an Associate of the Brussels Academy of Sciences.

SIR WILLIAM H. FLOWER has been elected a Foreign Member of the Royal Swedish Academy of Sciences, in the place of the late Prof. Huxley.

PROF. RAY LANKESTER has been elected a Corresponding Member of the St. Petersburg Academy of Sciences.

PROF. G. F. FITZGERALD, F.R.S., will deliver the Helmholtz Memorial Lecture at an extra meeting of the Chemical Society, to be held on January 23, 1896.

THE Valz prize of the Paris Academy of Sciences has been awarded to Mr. W. F. Denning for his observations of shooting stars, discoveries of comets, and other astronomical work.

THE Albert Lévy prize, of the value of £2000 sterling, has, says the *British Medical Journal*, been awarded by the Academy of Medicine to Drs. Behring, of Berlin, and Roux, Sub-Director of the Pasteur Institute in Paris, for their discovery of the means of curing diphtheria.

ONE of the special features of the exhibition to be held at Berlin next year is to be an interesting and instructive Department of Horticulture. This portion of the exhibition is being carried out under the direction of Herr L. Spath, an acknowledged authority on horticulture.

A CORRESPONDENT writes that on December 12, at about 6.10 p.m., he was walking towards Brownhills Station near Walsall, when he heard a loud hissing sound, and, on looking round, saw a meteor falling, of a blue colour, and dropping sparks in its course. It was travelling S. 20° W. and apparently at an angle of about 20° with the horizon.

A DESCRIPTION of another meteor has come to us through the Meteorological Office. Writing from Oakford, Bampton, North Devon, Lieut. Wolfe Murray says:—"Last night [December 17], at about 6.30 p.m., I observed a very brilliant meteor. The

brilliancy was such that it lit up the dark road (a lane with a high hedge) as though by a flash of lightning, or like a bright moonlight night. I turned and saw the meteor, almost due north from me, flash through about 5° of the sky, then separate into three distinct portions, of the following relative sizes roughly (

), and then vanish."

WE learn from the *British Medical Journal* that the Government of India have approved of a Committee, to assemble in Calcutta in January next, to revise the present cholera rules for the Forces, of which Mr. Hart spoke as inadequate and discreditable. The Committee will be composed of the Quartermaster-General in India, the Principal Medical Officers H.M. Forces in India, and the Sanitary Commissioner with the Government, associated with Mr. Hankin, the bacteriologist.

It is proposed to form a society to bring together more closely those who have taken up Reptiles as their hobby, and it is hoped that by this means interest may be kept up and mutual help secured by all concerned. Dr. Arthur Stradling has consented to become President. In order that a working basis may be secured at once, those who intend to become members should communicate with the Secretary, Rand Rectory, Wragby, Lincolnshire.

ON Friday last, several members of the British Chamber of Commerce, which has for some years advocated in the interest of English trade the adoption of the metric system in England, visited the boys' and girls' elementary schools of the Tenth Arrondissement at Paris, and listened to a lesson on the system, with the idea of seeing the ease with which it is taught and the efficiency attained. On Saturday, the members were received officially by the Paris Municipal Council, the President of which referred to the prospect that the metric system would be an additional link of fellowship between the two nations.

THE Annual Progress Report of the Geological Survey of Queensland is chiefly interesting from the account it contains of Mr. Jack's investigations into the artesian water supply of that country. A paper on the subject was read to the Australian Association nearly a year ago, so that the general results are not new. It seems probable that all the water obtained by sinking into the "Blythesdale Braystone" and other porous beds of the Lower Cretaceous is only an insignificant part of the total amount which must otherwise drain off into the sea, so that the amount of water obtained is capable of indefinite increase. There is a statistical appendix on the various artesian wells; and many matters of local geology are also dealt with in the report.

THE possibility that the ores and other vein minerals have been segregated in the veins out of the minute quantities diffused through the country-rock they traverse is so suggestive a one, that great interest attaches to any discovery that may throw light on this question. In New South Wales, auriferous granite has been known and worked for several years past in the Timbarra district. The rocks of this gold-field have recently been described by Mr. G. W. Card (*Records* Geol. Survey New South Wales, vol. iv. pt. iv. p. 154), who has found gold and silver in both the granite itself, which is a binary granite, and in eurite-veins which cut it. Moreover, small auriferous quartz-veins cut the granite. The exact mode of occurrence of the gold in the igneous rocks does not seem to have been made out.

THE diamond fields of Bingara, New South Wales, have been examined and reported on by Mr. G. A. Stonier, of the Government Geological Survey, with the view of ascertaining whether or not they resemble the deposits at Kimberley, in South Africa. It has been decided that no such resemblance can be made out, but no new light has been thrown on the genesis of the diamond. At Bingara, the diamonds are found in alluvial drifts of Tertiary age, in which pebbles of jasper, much waterworn, predominate, and nothing resembling the picrite-porphyry of Kimberley is found in the neighbourhood. It has long been held that the diamonds at Bingara were formed *in situ* in the drifts, but this view is not supported by Mr. Stonier. He suggests that the source of the diamonds is an intrusive mass of serpentine (an altered peridotite), which has metamorphosed the carboniferous rocks in the vicinity, producing great quantities of jasper, and of this, as already stated, the diamantiferous gravels are chiefly formed. The diamonds themselves are of superior quality to most of those found at Kimberley; but, being somewhat harder, take longer to polish. The largest stone found hitherto was only $2\frac{5}{8}$ carats in weight when rough, and not quite $\frac{3}{4}$ carat after it had been cut.

A RECENT number of the *Comptes rendus* (December 2, 1895, contains an account of a determination of the ratio v of the electrostatic and the electromagnetic units made by M. D. Hurmuzescu. The author has employed a method, first used by Maxwell, in which an electrostatic attraction is balanced by the repulsion between two circuits carrying a current. The electrostatic difference of potential at the ends of a known resistance R traversed by a current is obtained by an absolute electrometer with a cylindrical movable electrode. The current which passes through the resistance R also passes through an electro-dynamometer, the movable coil of which is rigidly attached to the lever carrying the attracted cylinder of the electrometer. This electro-dynamometer consists of a long solenoid with a single layer of wire, and of a small movable coil placed at the centre of this solenoid, and inclined at 90° to the axis of the solenoid. The value of the resistance R, for which the turning couples due to the electrometer and dynamometer are exactly equal, is found, and from the geometrical constants of the instrument the value of v can be calculated. The author considers that the length measurements, &c., are correct to 1 in 3000, and that the accuracy of the value of v is limited by the accuracy with which the ohm is known. The results obtained give values for v being between $3{\cdot}0005 \times 10^{10}$ and $3{\cdot}0020 \times 10^{10}$.

A NEW heavy liquid has been discovered. Mr. S. L. Penfield describes its preparation in the December number of the *American Journal of Science*. Mix equal proportions of the nitrate of silver and thallium, and on heating the mixture it fuses at 75° C., forming a clear mobile liquid of density 4·5, which mixes with water in all proportions. It can therefore be used to separate mineral particles of densities below 4·5. When still heavier particles have to be separated, the proportion of thallium may be increased. When the ratio is 3 : 4 the mixture fuses below 100° C. and has a density of about 4·7. At 2 : 4 the fusing point becomes 150° C., and the density 4·8; at 1 : 4 it is about 4·9, and fusion only takes place at 200°. Finally, when pure thallium nitrate is used, the point of fusion is 250° C., and the density closely approaches 5. This high range of densities, together with the fact that the salts do not attack many minerals, make the liquid especially valuable for mineralogical purposes. A convenient separator is described by the same author. It consists of a thimble-shaped cup into which a wide tube is made to fit. The tube can be closed at the bottom by a hollow plug. This plug being removed, the heavy liquid is poured through the tube into the thimble, and the minerals are thrown in and stirred. The heavy particles sink into the thimble, and may be removed by closing the tube with the plug, and withdrawing the thimble. The latter is then replaced, and the operation repeated with dilute liquid. With some practice an elaborate separation by densities is rapidly and easily accomplished.

A POSSIBLE method of determining the directions of atmospheric currents at high altitudes, independently of the observations of cloud movements, was suggested by Señor V. Ventosa, of the Madrid Observatory, in 1890; since then he has continued the investigation with great perseverance. The basis of the method consists in the observation of the undulations round the sun's limb, which are so trying to solar observers. In their greatest simplicity, these waves are tangential to the disc at two diametrically opposite points, and cut normally in the positions at right angles, all of them trending in the same direction. Usually, however, there are several superposed systems, and the difficulty is to separate them clearly one from another. The wind near the earth's surface is not often found to affect the appearances on the sun's limb, the explanation being that the waves produced by such a current must be greatly out of focus in the telescope. In fact, by varying the position of the eye-piece and determining the displacement necessary to bring the different systems of waves most clearly into view, the corresponding altitudes of the currents producing them can be found by applying the ordinary formula for conjugate foci. A large number of observations of this nature have been accumulated by Señor Ventosa, and as a control, observations of clouds have also been made; a tabulation of results certainly seems to indicate that the new method may be useful. Generally speaking, the direction of the superior currents is unlike that of the wind near the surface of the earth. A result of some interest is that on 150 days on which two currents were indicated, the mean height of the "neutral plane" was 2430 metres. It also appears that as the altitude increases the direction of movement usually changes in the opposite direction to the hands of a watch. The method seems to be well worth further investigation.

TWO important papers have recently been published on the effect of the electric light and of electricity on vegetation. The first is by M. Bonnier in the *Revue Générale de Botanique*. He states that a continuous electric light promotes the formation of chlorophyll, and brings about, at the same time, a simpler anatomical structure of the leaves. Under a continuous electric light the distribution of the chlorophyll in the tissues is more extended than in ordinary daylight; chlorophyll-grains make their appearance in the cortex as far as the endoderm, and even in the medullary rays and the pith. The palisade-tissue of the leaf is reduced, or entirely disappears, and the epidermal cell-walls are thinner. The bark is less developed, and the various tissues of the stem are less differentiated. When the electric light is discontinuous, as, for example, when turned on twelve hours out of the twenty-four, the effect on vegetation is intermediate between that of normal sunlight and that of a continuous electric light. Alpine plants cultivated under a continuous electric light exhibit points of structure identical with those of Arctic plants, which are exposed to almost continuous sunlight in the summer. The other paper is by Prof. A. Aloi in the *Bulletino* of the Italian Botanical Society. He adduces evidence in favour of his view that both terrestrial and atmospheric electricity exercise a favourable influence on the germination of seeds and on the growth of plants, and predicts that the employment of electricity will be a most important factor in the agriculture of the future.

WE have received a valuable memoir on the Greek earthquakes of 1894, from Dr. S. A. Papavasiliore, the director of the geodynamic section of the observatory of Athens. We have already (vol. l. p. 607) given a full account of these shocks, in summarising two preliminary papers by the same author.

THE Roman earthquake of last November 1, is the subject of a short paper read by Prof. Tacchini before the *Reale Accademia dei Lincei* ("Rendiconti," vol. iv., 1895, pp. 221–223). The area over which the shock was perceptible, without the aid of instruments, contains about 11,600 sq. km. The epicentre was probably near, or under the sea, in the neighbourhood of Ostia. Dr. Cancani estimates the depth of the seismic focus at about 15 km. Beyond the limits of the disturbed area, the shock was registered by microseismographs at Ischia, Siena and Florence. The times recorded by Prof. Tacchini, for Rome and Siena, give a velocity of almost exactly 2 km. per second.

IN the last number of the *Ornithologische Monatsberichte* (1895, p. 196) will be found an announcement that the German Zoological Society of Berlin has in contemplation a very important work, which will be entitled "Das Tierreich. Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen." The somewhat ambitious aim of this publication is, if we understand rightly, to give on an uniform plan descriptions of all the known species of the animal kingdom, together with their distribution and most important synonymy. Prof. F. E. Schultze, of Berlin, has undertaken the general editorship of this work, but will be assisted by specialists in the different branches of zoology.

THE Royal Meteorological Institute of the Netherlands has made a valuable contribution to maritime meteorology by the publication of a large folio atlas of the Guinea and equatorial currents, embracing that part of the Atlantic Ocean between lat. 2° and 24° N., and from the west coast of Africa to long. 29° W., which includes the limits of the African North Polar current. The charts, of which there are several for each month, show clearly how the Guinea current divides into two branches, one setting to N.E. and the other to S.E., the various changes in the temperature of air and sea-surface, the regions of trade winds, calms, rain and other phenomena. The principal direction of the Guinea current being towards the east, while the equatorial currents set towards the west, the former is represented in black and the latter in red. The materials for the charts have been obtained entirely from logs kept on Dutch vessels.

AN interesting paper by Miss Grace E. Cooley is reprinted from the *Memoirs* of the Boston Society of Natural History, on the reserve-cellulose of the seeds of *Liliaceæ* and of some related orders. She states that reserve-cellulose appears, as such, on the walls of the cells soon after the endosperm is formed. Sugar and oil are present in the cells before the appearance of reserve-cellulose and during the process of the thickening of the wall, the sugar being formed first. The reserve-cellulose appears first at the angles of the cells, and extends thence to the walls. The cells of the endosperm near the chalaza are the first to have their walls thickened; those next the integuments are next affected, and the cells near the embryo are the last to mature. The paper is illustrated by six quarto plates.

A VALUABLE monograph on water supplies, by Mr. Allen Hazen has just been published, and should prove of great value to engineers and others in charge of water-works. Mr. Hazen was lately chemist in charge of the well-known Lawrence experiment station of the Massachusetts State Board of Health, and is, therefore, specially qualified for the task he has undertaken, and in the carrying out of which he has been so successful. No trouble has been spared to obtain the latest and most trustworthy information on water-works from all parts of the world. The change which has come over the conduct of water-works since the introduction of the modern methods of bacteriology is, of course, shown very clearly, and it is pointed out how, in our country, Dr. Percy Frankland's investigations, published in 1885, on the removal of bacteria by means of sand-filtration at the London Water-works, and in Germany those of Wolffhügel, Plagge and Proskauer at the Berlin Water-works, published in 1886 and 1887, were the means of furnishing the first insight into the hygienic significance of filtration.

WE have on our table several volumes published by learned societies, but limits of space will not permit us to do more than refer to them briefly. One of these volumes is the twenty-second (new series) of the *Proceedings* of the American Association of Arts and Sciences, and contains twenty-two papers read before the Association between April 1894 and May 1895; among them being papers on the North American Centhophili, by Mr. S. H. Scudder; nitro-paraffine salts, and bivalent carbon, by J. U. Nef; wave-lengths of electricity on iron wires, by Mr. C. E. St. John; the blastodermic vesicle of *Sus scrofa domesticus*, by Mr. A. W. Weysse; ternary mixtures, by Mr. W. D. Bancroft; a revision of the atomic weight of strontium, by Mr. T. W. Richards; and on the relation of hysteresis to temperature, by Messrs. F. A. Laws and H. E. Warren. Another volume to which we can only briefly refer is the *Atti d. Accademia d. Scienze Fisiche e Matematiche* of Naples (vol. ii second series). In this we find memoirs on Italian Hymenoptera, by Prof. A. Costa; on certain Abelian equations, by Prof. V. Thollame; comparison of Right Ascensions simultaneously determined at Capodimonte and Cordoba, by Prof. A. Nobile; earth-currents, by Prof. Palmieri; Italian fossil ichthyology, by Prof. F. Bassani; and several others. We have also received a volume of the *Journal of Conchology*, the first published under the direction of the Conchological Society; vol. xxvi. of the *Proceedings* of the Boston Society of Natural History (part iv. 1894–95); and a number of maps from the Geological Survey of Canada. One batch of these maps exhibits the principal auriferous creeks in the Cariboo mining district, British Columbia; a second bundle refers to the geology of Guysborough, Antigonish, and Pictou Counties, Nova Scotia; while a third contains a geological and topographical map of the southern part of the lake of the Woods and Rainy River, Ontario, Eastern Townships Map, Quebec, and a sheet showing the geological character of South-west Nova Scotia. Finally, we have to acknowledge the receipt of vol. v. part i. (second series) of the *Proceedings* of the California Academy of Sciences, a volume of nearly eight hundred pages filled with valuable papers on Californian natural history; and the second volume of "Beiträge zur Geophysik," edited by Prof. Dr. G. Gerland. In this volume we find a speculative paper on terrestrial magnetism, by Prof. A. Schmidt; a very long account and discussion of observations made with the horizontal pendulum at Strassburg, during 1892–94, by the late Dr. E. von Rebeur-Paschwitz; an extensive collection of observations of submarine earthquakes and eruptions, by Dr. E. Rudolph; and a critical study of the mean level of the solid crust of the earth, of the land and water areas, and of the relation between the land above sea-level and oceanic depressions, by Dr. H. Wagner.

OUR ASTRONOMICAL COLUMN.

ORBITS AND ORIGIN OF COMETS.—The investigations of Schiaparelli led to the conclusion that comets moving in parabolic orbits must have originally had a very small velocity with respect to the sun, and that, apart from planetary perturbations, the probability of elliptic orbits is very small. The latter fact is demonstrated in a somewhat different way by M. V. Wellmann (*Bulletin Astronomique*, vol. xii. p. 515), the absolute velocities of the sun and comets being introduced. This method leads to the conclusion that the formation of hyperbolas is much more probable than that of ellipses, and that ellipses of large dimensions are much less probable than smaller ones; further, the supposed parabolic orbits which have been calculated are probably nearly all hyberbolas.

In conformity with the nebular hypothesis, M. Wellmann regards the substance of which comets are formed as the débris of nebulous matter not attached to any system in the process of condensation, but in unstable equilibrium, and having nearly the same proper movement as neighbouring centres of condensation. Eventually assuming a hyperbolic orbit round a neighbouring sun, the "cosmic cloud" passes off into space, and may become attached to our system *en route*.

M. Wellmann goes on to demonstrate that under the influence of a solar electrical repulsion, elliptic orbits will approach the parabolic form. Hence, in calculating the definitive orbits of comets, this repulsion should not be lost sight of; even neglecting planetary perturbations, a comet may not move rigorously in a conic section. In cases where calculation and observations are discordant, it is suggested that a reconciliation be attempted by supposing that the "constant of attraction" is itself variable, in consequence of the varying electrical repulsion. M. Wellmann also seems to be of opinion that this force of repulsion may be found sufficient to explain the inequalities in the movement of Mercury, which Leverrier ascribed to a possible intra-mercurial planet; the suggestion that the law of gravitation is not strictly true (NATURE, vol. li. p. 183), adds to the probability of this explanation.

COMET BROOKS, 1895.—Attention is drawn by Dr. Deichmüller to a striking similarity between the elements of Comet Brooks 1895 and those of the comet of 1652 (*Ast. Nach.*, 3322); this is shown by the following comparison, in which Kreutz's elements for Comet Brooks are adopted:—

Comet 1652.	Comet Brooks.
T = 1652 Nov. 13	T = 1895 Oct. 21
$\omega = 300^\circ\ 10'\cdot6$ } 1895	$\omega = 298^\circ\ 13'\cdot0$ } 1895
$\Omega = 91\ 33\cdot0$	$\Omega = 83\ 9\cdot2$
$i = 79\ 27\cdot7$	$i = 75\ 22\cdot8$
$q = 0\cdot847$	$q = 0\cdot839$

The continued ephemeris for the comet, following Dr. Berberich, is as follows:—

	R.A. h. m. s.	Decl. ° ′
Dec. 27	3 18 39	+68 45·1
28	3 9 42	68 34·2
29	3 1 38	68 22·1
30	2 54 22	68 9·2
31	2 47 51	+67 55·6

THE MOVEMENTS OF HORIZONTAL PENDULUMS.

THE movements of horizontal pendulums referred to in this note are those which have been observed in Japan and the Isle of Wight. In reports to the British Association on the earthquake and volcanic phenomena of Japan in the years 1883, 1884, 1885, 1887, 1888, 1892, 1893, and 1894, abstracts are given of work which has been carried out in that country in the investigation of earth tremors or pulsations, diurnal waves, and other earth movements. The Report for 1892 describes a pair of extremely light horizontal pendulums, the movements of which, with the aid of mirrors and lenses, were recorded on photographic plates and films, and gives some account of the analysis of the resulting records. The observations were continued during the following year, when it was observed that the direction of earthquake movement in many cases coincided with the direction in which strata had been folded to form mountain ranges bordering the Tokio plain. Another observation was that certain earthquakes had been preceded by an abnormal amount of tilting. During the last year, largely in consequence of the liberality of the Royal Society of London, I have been able to extend these observations, and records have been obtained from horizontal pendulums, each provided with photographic recording apparatus, from nineteen installations. The more important of these installations were as follows. At Tokio in my house, on a massive stone column. At a place 1000 feet distant, in an underground chamber, excavated in the alluvium on a concrete bed. At Kanagawa the observatory was in an artificial cave, driven at a depth of about 50 feet in soft tuff rock beneath its junction with overlying alluvium. At Yokohama two instruments were placed in a cave on the tuff rock, about two feet below its junction with the alluvium. At Kamakura two instruments were placed in a cave on hard tuff, which dips at an angle of 30° north-east.

These instruments were oriented so that their booms pointed north-west or north-east, or parallel and at right angles to the dip of the rocks. The localities mentioned are at distances from Tokio of twenty, twenty-three, and about thirty-three miles.

The remaining installations were on brick columns rising from a bed of concrete on the alluvium, the localities being chosen with regard to the surface configuration and the proximity or absence of a covering of forest or buildings which would influence the effects of solar radiation. Underground and in the caves, which represent seven out of the nineteen installations, the daily change in temperature was not appreciable on the diagram from a self-recording thermometer. At other stations this change was often very great.

The Instruments.

The pendulums consisted of a horizontal boom about 5 feet in length, held up by a fine brass wire. They had different degrees of sensitiveness. Usually the adjustment was such that the outer end of the boom was displaced 1 mm. by tilting the bed plate of the apparatus from 0″·1 to 0″·5. At the extremity of the boom there is a light metal plate with a slit in it parallel to the length of the boom. Underneath this floating slit, but at right angles to it, there is a narrow slit in the top of a box. Light, after passing through the two slits, goes into the box as a point which is received on a drum carrying a photographic film, which usually lasted one week.

No accuracy of adjustment is required, and if the pendulum is steady without the aid of a single lens, the photographic trace is a remarkably clear line.

If there are two slits—one broad and the other narrow—in the floating plate, two lines may be produced, one of which is thick, and the other extremely fine. For quick movements of the pendulum, the best diagram is given by the former, whilst for slow displacements the latter has the clearer definition.

A modification of these arrangements is one which I used in Japan, and which is now in operation at Shide, in the Isle of Wight. In this instrument the boom is built up of straw and reed about 2·5 feet long, and weighs less than ·25 oz. At its outer end there is a small mica plate, which is blackened, and has two slits in it parallel to the length of the boom. At a distance of 1·5 inches from its inner end, where there is a brass socket and an agate cup, a pivoted weight is so arranged that it balances the outer part of the boom. The apparatus is therefore equivalent to an extremely light conical pendulum seismograph, which multiplies tremor-like motion about sixteen times, but which is at the same time very sensitive to changes in the vertical. When the pendulum has a period of sixteen or eighteen seconds, one millimetre deflection of the end of the boom indicates a tilting of 0″·70. The record is received upon a roll of bromide paper passing beneath a fixed slit in the lid of a box, above which is the boom and mica plate. This moves at a rate of about forty-two millimetres per hour. Should this paper move at a varying speed, this is checked by an ordinary watch so placed upon the lid of the box with the fixed slit, that its long hand every hour crosses freely over a portion of this slit not covered by the floating plate, and by eclipsing the light, causes hourly time-marks to be made on the band of bromide. On many occasions I have caused the pendulum to move at *known* times, and subsequently determined the times at which these disturbances took place by measurements made on the bromide film after development. The errors usually varied between three and ten seconds.

These pendulums have worked well in damp caves and with unskilled assistants. One assistant was a shopkeeper's daughter, twelve years old, whose duty it was to refill and light a benzine lamp every twenty-four hours. The records obtained were very much freer from tremor effects than anything I have obtained when working with a pendulum, the boom of which was a two-inch piece of aluminium wire held in position by a quartz fibre, and giving its record by mirrors and lenses.

The movements recorded have been as follows.

(1) *The Wandering and Long-period Movements of Pendulums.*

All the horizontal pendulums wherever situated have slowly wandered from their normal position. Those on the rock have often gradually moved to one side and then returned, the double excursion usually taking from two days to a week. Underground on alluvium *within twelve feet of water-level* the wandering was at times so great that the spot of light left the film, which was two inches broad, and readjustments were often necessary. From the readings of the end of the pointers, it would appear that in some cases at least, had the pendulums been given sufficient time they might have returned to their starting point. The pendulum in my house, one thousand feet distant from those underground, but *thirty-six feet above water-level*, although usually more sensitive than those beneath the surface, wandered to a less degree. These wanderings might be due to a local warping of the supporting column, but inasmuch as it has generally happened that the periods of great movement and of comparative rest of different instruments have coincided in time, it would seem that the movements are in all probability due to a more general cause. Because great movements have usually been marked (but by no means always) at or after a rainfall, some of them may be attributed to fluctuations in the volume and flow of underground water, the pendulum nearest to this water moving the most.

The other movements, especially those of the pendulum, situated in my house, and those of the instruments on the rock, have been accompanied by local earthquakes, conveying the impression that they represent actual rock bending, the earthquakes being interruptions in the process. As the number of observations are limited, and as I am not in a position to determine which of the earthquakes recorded in Tokio are of local origin, and which originated at a distance, although the materials for making this determination have been accumulated at the Central Observatory in Tokio, the matter is one requiring further attention.

Two pendulums on the alluvium, four hundred yards distant from each other and very differently installed, for periods varying between four and forty days, have moved at the same time in the same directions.

These movements may therefore be due to some general cause. A rough agreement with a barometric curve suggests the idea that the cause is due to variations in atmospheric pressure, but it is equally possible that they may be due to a greater evaporation or precipitation of moisture on one side of these stations than upon the other sides.

(2) *Diurnal Waves.*

By a diurnal wave I mean a deviation of the vertical during one portion of a given period of twenty-four hours in one direction, followed by a retrograde motion during the remaining portion of this interval. On rock foundations my instruments, which never had a sensibility exceeding 1 mm. deflection for a tilt of 0″·1, have failed to show such a movement. With instruments having a greater sensibility it is likely that its presence would be detected. These movements, which may, for example, be shown by a westerly displacement of a pendulum through a distance of from 2 to 40 mm. from about 6 a.m. until about 3 p.m., and an easterly motion until the following morning, may be best studied from diagrams on films which have moved at a rate of about 3 or 4 inches per day.

In the underground chamber in the alluvium, within 12 feet of the surface, where the daily change in temperature was less than 1° C., the daily waves were often marked. On the surface at my house, on a good foundation protected by a long building, the wave was marked, but slight.

At stations protected on all sides by high trees from the sun it was feeble. At all other stations, where on one side at least there was open ground exposed to the sun, with the *exception of rainy or cloudy days, when the photographic trace was a straight line, it was very marked, the deflection sometimes amounting to 40 millimetres*. On one hill, from about 6 a.m. to 6 p.m. the motion was westwards, while at the other side of a swampy valley running N.N.W. the movements were at the same hour almost in a contrary direction. It would appear that on every fine day the trees on the hills on the two sides of this valley bow first towards and then away from each other.

For the present I am inclined to regard these phenomena as being due to a tilting of the surface in consequence of the evaporation of moisture. This effect extends to some depth.

On open ground in the morning more moisture is taken away from the eastern side of a station, than from the western side, and therefore the eastern side, being relieved of a load, rises, and the pendulum swings westwards.

In the afternoon this action is reversed, and the pendulum turns eastwards.

The waves due to this effect differ in time of occurrence and in amplitude according to the character of the locality in which they are observed.

The movement at night is slight. It may be a continuation of the sun effect modified by the precipitation of dew from the atmosphere, and by the condensation of aqueous vapour rising in ground heated during the day but chilled on its surface after sunset. The sub-surface condensation sometimes represents a load one-tenth of that taken away by evaporation. Like dew

and evaporation, its amount varies daily, and with localit and on two sides of a given station it reaches a maximum at different times.

Experiments bearing upon these Suggestions.

(1) Ten men and boys, representing a load of about 1000 lbs., at a distance of 15 feet from the stone column carrying the pendulum in my house, causes it to move as if the ground had been depressed upon the side of the load.

(2) By quickly emptying a well, which is distant about 100 feet from the above column, of about two tons of water, which was run off down a hill, the pendulum moved away from the well, behaving as if the ground had been relieved of a load on that side.

(3) A self-recording tide-gauge was set up in an unused well 80 yards distant from the underground chamber. This showed that the water in the well rose and fell $\frac{1}{4}$ to $\frac{1}{2}$ inch *twice* every 24 hours. The times of sinking, which occur in the morning and the evening, may correspond with the times at which the most water is being drawn from wells in the city. I have not determined whether these movements have any influence upon a small wave which is often superimposed upon the large diurnal wave.

(4) I find from experiment that on fine days the ground in my garden may lose by evaporation 4 or 5 lbs. of moisture per square yard, or from an area measuring 20 by 20 yards about 1 ton.

I also observe that during a bright fine day that, in most cases, pendulums move away from areas that are being relieved of loads in this manner, and which may therefore be rising.

(5) Because it often happens that a board which has been lying on the grass all night is found in the morning to be wet on its under side, whilst all around the grass may be dry, the following experiment was made on sub-surface condensation. Two shallow trays about 1 foot 6 inches square were filled with earth, and placed on a flat surface of earth in my garden. One of these trays had a bottom of sheet tin, whilst the other had a bottom of fine wire netting. These were weighed morning and evening, and it was found that sometimes the box with the fine wire netting had increased in weight, while the other had not changed. The inference from this is, that during a hot day the ground is sensibly heated to a depth of one foot. This was proved by diagrams from self-recording thermometers, which for periods of a week had been buried at varying depths. After sunset the surface of the ground is quickly chilled, and aqueous vapour rising into this is condensed to augment the surface weight.

An open area, which during a day may have lost more weight by evaporation than a neighbouring area which is covered, will, if both areas are connected with the same subterranean water supply, gain the most in weight, not only by an action of this sort, but also by the condensation of moisture as it escapes from the surface, and by the precipitation of moisture from the atmosphere. These actions may in part account for the retrograde motion of pendulums during the night. Although differential evaporations and condensations are apparently sufficient to account for certain observations made in Japan, other observations exist to which they are not so apparently applicable. The cause of diurnal waves is therefore not yet known with certainty.

(3) *Earth Tremors.*

The continuous photographic records taken in Japan have thrown much new light upon the occurrence of tremors, while an experiment made at Shide in the Isle of Wight, where a light horizontal pendulum has been established to record earthquakes having their origins in distant localities, has indicated a cause of movements which probably have often been attributed to movements of the ground.

We know that tremors are more frequent during the winter than during the summer, that they are frequent with a low barometer, and still more frequent when the locality of observation is crossed by a steep barometrical gradient. From these latter accompanying conditions, it may be inferred that tremors may occur whenever a strong wind is blowing, although near to the observing station the atmosphere may be perfectly calm. Recent observations in Japan have shown that tremors are more frequent during the night than they are during the day, and that maxima of motion are reached between 5 and 9 a.m. In fact, some instruments have always shown movements about these hours. One very important observation is that the greatest movements have been recorded by the lightest pendulums. For example, a pendulum having a boom from one quarter to four inches in length is a better tremor recorder than one which has a boom several feet in length.

The pendulum at Shide was set up upon a newly-built brick pier. Because moisture was given off from this, the inside of the covering case became exceedingly damp, and the bromide film became sticky. To overcome this difficulty, two trays of calcium chloride were placed inside the covering. A few minutes after this it was observed that the pendulum commenced to swing. When the calcium chloride was removed the pendulum came to rest. This experiment was repeated several times, and the conclusion arrived at was that rapid desiccation produced air currents of sufficient intensity to cause a light pendulum to move, and the diagrams of these movements are not distinguishable from those attributed to *earth* tremors. Although experiment has shown that differences in temperature of the walls enclosing a light pendulum will cause the same to swing, I have no reason to think that movements due to such causes have been recorded. All that can be said at present is that a difference in the rate at which moisture is absorbed by or evaporated from the different walls of a casing covering a light pendulum, may cause the same to swing. Before we should attempt to explain why such movements are marked at particular hours, and occur with certain meteorological conditions, the necessity of further experiments is obvious. Air currents can hardly explain a set of tremors lasting several hours, where a seventeen seconds pendulum moves back and forth with uniform amplitude and a uniform period of two or three minutes.

(4) *Earthquakes.*

At Kamakura, on the hard rock, the greatest earthquake motion has been given by the pendulum which records tilting parallel to the dip—suggesting the idea that in this direction there is an easier yielding (like the opening and shutting of a concertina) than there is in a direction parallel to the strike. The movements, even for unfelt earthquakes, are sometimes as much as 40 mm., and a disturbance may continue for several hours. On March 22, I and my colleague, Mr. C. D. West, watched an earthquake for 1 hour and 47 minutes, during which time the pendulum did not *swing*, but was *forced* backwards and forwards intermittently, and with extreme irregularity. These earthquakes are in the form of earth waves, and usually come from a great distance. A sharp shock which may be felt throughout Tokio and at many places in the country, does not disturb the pendulums, and it is difficult to find a blurr on the photographic trace.

As in previous years, before certain local earthquakes I have observed abnormal tilting, an explanation for which is suggested in the section on the wandering of pendulums. It is seldom that abnormal tilting has taken place without local disturbances. Local disturbances, unless they are large, which fortunately is of rare occurrence, are only recorded by seismographs.

One disturbance which I recorded at three stations in Japan was one which had its origin near to the antipodes of that country in the Argentine Republic. The conclusion to be derived from this and other observations is that a large earthquake may be recorded at any point upon the surface of the earth. The preliminary tremors seem to reach distant places with a velocity twice or three times that with which mechanical vibrations can be transmitted through glass or steel. Possibly they come *through* our earth, which therefore may have a higher effective rigidity than hitherto supposed. The undulatory motions which follow the tremors may be transmitted as surface quasi-elastic gravitational waves. Their velocity of propagation lies within the limits of expectation. The chief object of the instrument established in the Isle of Wight is to determine whether it is sufficient to record the unfelt movements due to earthquakes originating in distant localities.

The first certain records of earthquakes having their origin at great distances were obtained by Dr. E. von Rebeur-Paschwitz, whose recent death has deprived the world of one of the most active workers in the new field which has been opened to seismologists.

JOHN MILNE.

THE ANTWERP METEOROLOGICAL CONGRESS.

TAKING advantage of the attendance of numerous visitors, scientific and otherwise, that the Antwerp Exhibition was likely to attract, it was proposed to hold, under the auspices of the Geographical Society of that city, a congress on meteor-

ology, aerial navigation, and allied subjects, with the particular object—as we gather from the circular convening the congress—of promoting the methodical and general observation of aerial currents. Authorities propose, but contributors decide, the result and character of the meeting, and the *compte rendu* of the congress, which has just reached us, shows that while a variety of interesting topics was brought under the notice of the members present, and discussed with greater or less detail, the ultimate aim of the promoters does not seem to have been materially advanced. Of course, the awakening of public opinion and the diffusion of information are always desirable, and the Committee responsible for the congress are to be congratulated upon the general success which has attended their efforts, though it may not be precisely in the direction they proposed to themselves.

One circumstance certainly told against the development of any complete plan, demanding the co-operation of many nationalities. The date of the congress (August 16–18) was unfortunately chosen. It clashed with the meeting of professional meteorologists, who were in session at Upsala, and thus prevented the attendance of those who could have given authority to any well-considered scheme, whose guidance would have been welcome, and whose reputation would have added weight. The President (Lieut.-General Wauwermans) had to announce, therefore, many letters of apology for non-attendance from men of science who had hoped to be present. His address was in the main historical, dealing with the progress of aeronautics and ballooning from the time of Montgolfier to the present, and a consideration of the benefits that would accrue to many mechanical applications from the more perfect knowledge of atmospheric motion and aerial currents. This address was delivered to the whole congress, which afterwards divided into two Sections—one, under the presidency of M. Lancaster, to discuss the subject of aerial currents; the other, directed by M. Van den Borren, more immediately concerning itself with aerodynamics.

To the first Section, M. Lagrange contributed a paper on the sympathetic movements of freely-suspended needles, whether magnetised or not. These practical experiments are the outcome or completion of a mathematical inquiry, published by the author in 1892, entitled, "Étude sur le Système des Forces du Monde physique." The experimental inquiry has been spread over more than two years; while two sets of apparatus—one in the cellar of the observatory, the other on a level with the ground—have been under observation. The direction in which the needles point is not constant; but both sets show a tendency to travel in azimuth from north-west to south-east from April to June, and then to retrograde towards the original position. The reason for this oscillation is discussed at great length; the author attributes it to the mechanical conditions under which a permeating fluid similar to ether would be placed when affected by all the forces, gravitational and electrical, that are continually operative. The practical result is, that further observations, conducted at a depth 30 metres below the surface, are to be prosecuted at the Royal Observatory, Brussels, and a member of the congress will carry out similar observations at the Meteorological Institute of Roumania. Canon Spée discussed the well-worn question of a possible connection between the area of spotted surface on the sun and the temperature of the earth, and, like others before him, is driven to the conclusion that any connection is not apparent. The meeting closed with a new theory of tides, both oceanic and atmospheric, but the "new" theory was not well received, and is not described in the *Compte rendu*.

At he second meeting of the Section, some papers of minor importance were read and discussed. One member read a note on the treatment of diseases of the ear by compressed air, and invoked the aid of meteorologists in a matter of aero-therapeutics. Another had something to say on the forces that affect the rotation of the earth, but this was summarily dismissed as a theory "qui aboutit à la fois à des déductions d'ordre scientifique et d'ordre philosophique." Another had arranged a system of magnetic needles with a view to the solution of the problem of weather prediction. The subjects, it will be seen, were sufficiently varied; we can only refer to two. One, by M. Lancaster, on the preparation of synoptic charts, in which he insisted on the regular publication of maps showing atmospheric currents. He indicated the progress that had been made in investigations of that character, and suggested the formation of an international bureau for the consideration of the subject. A vote of the congress supporting his views was forwarded to the Meteorological Congress sitting at Upsala.

M. Plumandon, meteorologist to the Observatory of the Puy de Dome, read a paper on the causes of storms and atmospheric disturbances. He had availed himself of the difference of altitude of the Puy de Dome (1467 m.) and of Clermont Ferrand (388 m.) to compare the variations of barometric pressure at the two levels. In summer the pressure is raised less above or falls more below the mean value at Clermont than at the summit of the Puy de Dome. The opposite rule obtains in the winter. M. Plumandon deduces from his discussion that the production of storms coincides with the greatest separation of the two barometric curves, and that storms cease when the separation is sufficiently small. Put otherwise, this means that storms occur when the ascending currents reach a sufficient intensity, and, further, that absolute values of the pressure are of less importance in producing storms than the magnitude of the separation of the barometric curves at a high and low level. M. Plumandon has also interesting remarks on the relative velocities of wind at high and low stations in the same district, derived from observations at Pic du Midi and Toulouse, at Tour Eiffel and Parc Saint Maur, Paris, and other places, from which it appears that the higher station does not always suffer most from violent winds, but that there are regions at considerable altitude where the air is on the whole less agitated than at the surface of the ground.

In the Section devoted to aerodynamics, M. Van den Borren gave an able address on the subject of aerial navigation as it stands to-day, enriched by the experiments of many able mechanicians. M. Borren, as chief of the military aerostatic service of Belgium, and having charge of the School of Aerostation at Antwerp, was able to give an interesting account of what had been there accomplished under his own eye. Experiments have been carried on to determine the resistance offered by the air to planes at different inclinations, and to surfaces of various figure, as well as to the preparation of machinery arranged for different rates of locomotion and constructed of various materials with the view of determining the friction of the air on different substances. That is to say, the problem has been studied with all the attention that experience has suggested, and the conclusion to which this expert arrives is, that the problem of aerial locomotion no longer presents any serious difficulties, that the theory is satisfactorily established, and that one may venture to proceed to execution. Neither does size offer any insuperable objection to this optimistic view. He calmly contemplates the manufacture of an aerostat 300 metres long by 30 broad, dimensions which approach, if they do not exceed, those of an Atlantic liner. An historical sketch of the progress of meteorology closed the sitting.

At the second meeting, M. Lancaster gave an account of the observations on the velocity of the wind in Belgium. In the main the author agrees with the results to which M. Hann, of Vienna, had been previously led. The paper, which is of great interest, appears in full in an annexe, forming the second part of the *Compte rendu*, being the memoirs presented to the congress. Another paper, to which we give only a brief reference here, is from M. Ventosa, astronomer at the Observatory of Madrid. It has for its object the determination of the direction of wind at high levels from observation of star images, and also that of the sun. This subject came before the meteorological committee at Upsala, and seems to have been well received, since M. Ventosa was encouraged to continue his observations (see NATURE, vol. li. p. 185; also p. 179 of this number).

THE HUXLEY MEMORIAL.

THE following is the official report of the first meeting of the General Committee, formed for the purpose of establishing a memorial to the late Right Hon. T. H. Huxley, P.C., held in the Museum of Practical Geology, Jermyn Street, on Wednesday, November 27, 1895. Present—250 Home Members of the General Committee. His Grace the Duke of Devonshire, K.G., in the chair.

The Duke of Devonshire, in opening the proceedings, said:—

My Lords and Gentlemen,—It would be in the highest degree presumptuous on my part if I were to attempt, in the presence of so many distinguished men of science as I see around me, to offer anything in the nature of an estimate of the character and work of Prof. Huxley, or of the services which he has rendered

to science, either as an original investigator or as an exponent. As, however, I presume that it is as the official head of the Science and Art Department that I have been asked to accept the chairmanship of this Committee, it may be proper that I should open the proceedings by a very brief statement of the official connection of Prof. Huxley with that Department, although I am perfectly aware that the services which he rendered to that Department, valued and valuable as they were, form but a very small part of the work which Prof. Huxley did for science; which, both during his lifetime and since his death, has been so fully recognised by every scientific man in the country.

Prof. Huxley, immediately after leaving the Navy, in which he commenced his career, succeeded in 1854 Prof. Forbes, as Lecturer on Natural History in the Central School of Science in Jermyn-street. This school subsequently became the Royal School of Mines. It was transferred to South Kensington in 1881, and there merged in the Royal College of Science. Prof. Huxley was the first Dean of the College, and on his retirement from the public service in 1885, he was requested by the heads of the Department to retain the office in an honorary capacity. This he did, to the day of his death; attending the meetings of the Council, and giving assistance in other ways. He was also Honorary Professor of Biology in the College, retaining a general charge of the biological section. While Professor at the College he developed his system of biological teaching—which has had so marked an influence on biological teaching in all parts of the world. On his retirement in 1885 he presented to the College the large and valuable collection of books on natural history which he had formed. The room which he occupied was, by the authority of the Lords of the Committee of Council on Education, devoted to a Huxley Biological Laboratory for research, and it is in constant use by advanced students of biology. A scholarship has been endowed in connection with the College, and the history of that endowment may be of some interest. Prof. Huxley on one occasion met in society Miss Marshall, the daughter of Mr. Matthew Marshall, for many years Chief Cashier of the Bank of England, and in consequence of a conversation which she had with Prof. Huxley on that occasion, she left to the Department a large number of books and instruments and, in addition, a bequest of £1000, from the proceeds of which the scholarship referred to has been endowed.

Prof. Huxley was, for more than forty years, intimately connected with the Science and Art Department. The Jermyn Street Museum, in which we are met to-day, is a section of that Department, and both in this lecture-theatre and in the classrooms upstairs, Prof. Huxley for many years delivered his lectures.

It was almost my first duty—and I need not say, my painful duty—after I became President of the Council, to address (on the part of the Committee of Council on Education) a letter of condolence to Mrs. Huxley, in which the Committee placed on record its high appreciation of the services to science and art rendered by Prof. Huxley in the capacities to which I have referred, and in addition, on many inquiries by Royal Commissions, in which he had taken part. I am quite aware that the time of those who are here is valuable, and I shall, therefore, not detain you any longer, but must leave to others the duty of expressing the recognition of the whole of the scientific world of the brilliant life and labours of Prof. Huxley. I have thought, however, that this brief reference to the official side of Prof. Huxley's career might not form an inappropriate introduction to the wider view of his work and of his character, which it will be the duty of those who are to follow me to present to you.

Prof. M. Foster (Joint Honorary Secretary of the Provisional Committee), after referring to a number of letters expressing regret at being unable to be present at the meeting, gave a brief history of the movement for establishing a memorial, as follows:—

Very shortly after the death of Prof. Huxley, a few of his personal friends met together in the rooms of the Royal Society; they thought they would be carrying out the wishes of all by promoting such a memorial, and invited a number of representative and influential persons to meet to consider the matter. They met, and it was then thought desirable to take further steps; they therefore constituted themselves a Provisional Committee, and sent out invitations to a very much larger number of persons to form a General Committee. These invitations were very cordially received, and, among others, we had the pleasure of hearing from H.R.H. the Prince of Wales that he would join the Committee, and would, further, accept the duty of Honorary President. At that time the summer was too far advanced to take any active steps, and the meeting of the General Committee was postponed until the present date. In the meantime we approached his Grace the Duke of Devonshire, asking if it would be his wish to act as Chairman of the Committee, and his Grace kindly accepted this duty. The Provisional Committee have given much time to the consideration of various suggestions made as to the form which the proposed memorial should take; and certain resolutions, embodying the decisions arrived at, will be submitted to you; and it is for you to decide how far they shall be carried into effect.

Lord Kelvin, P.R.S., then proposed the first resolution:—

"That it is desirable to establish a memorial to the late Right Hon. Thomas Henry Huxley."

He said:—As an original investigator in biology, Huxley has, by his life-long perseverance in working for the increase of natural knowledge, left to the world a monument more enduring than any bronze or marble in which his survivors may give material expression to their gratitude. Of his originality he gave early proof. Whilst still a student in Charing Cross Hospital, he made an exceedingly skilful and acute microscopic investigation of the structure of hair; he discovered a special structure, and described it in a communication to the *Medical Times and Gazette* with so much effect that, to this day, it is known as "Huxley's layer." That was something for a young medical student to have done. His indomitable resolution to go on with work; his attraction to original investigation—an irresistible passion of his through life—was manifested from beginning to end. Soon after his technical school education in medicine was completed, he went away as medical officer to the *Rattlesnake*, on a four years' cruise. Happily, his medical duties left him some leisure; that leisure he employed in a series of most important investigations in natural history, which has made the cruise of the *Rattlesnake* celebrated in the annals of science. I cannot tell you how many memoirs he sent home from the *Rattlesnake*; some of them never came back; one he found on his return, in the shape of a memoir communicated to the Royal Society and published in its *Transactions*; it is known to all naturalists, and is admitted to be a very valuable and important paper. Several other papers were sent, including one very important paper—although it only occupies half a page of the Report of the British Association—dealing with the blood corpuscles of certain marine animals picked up in the surveying work of the *Rattlesnake*. These first works done, not in a scholastic manner as a thesis for a Degree of Philosophy, but simply from the innate fire and determined purpose of the worker, were but the beginning of a long series of memoirs which soon made the name of Huxley famous throughout the scientific world. He was very early recognised to be one of the first biological investigators of the day, and the value of his work will be declared to you by others who know thoroughly the merits of the work and the wants which that work supplied in natural science. They will tell you that his work in Comparative Anatomy was of very great value indeed; that he almost created a new era in biological science, by the great advances that he gave to the new Morphology. He carried out and extended, in the most admirable and valuable manner, the work of Von Baer and Johannes Müller, tending in this direction, and now we have—what medical students and students of natural science in Huxley's student-days could learn nothing of in school or university—we have Morphology and General Biology taught regularly and systematically; and, I believe, I may safely say, not only to the great benefit of medical science, but to the great benefit of science in general; to the great benefit of those who are studying science for the sake of knowledge and of opening their minds, and of understanding the grandeur and beauty of nature and what lay underneath it.

Huxley's work was not confined to miscroscopic examination and the dissection of plants and animals—comparative anatomy generally, including the vegetable world—although it began with that. He entered on the subject of geology and of palæontology in a manner which has left fruit of a most enduring character, especially in palæontology: his tracing of relationships, and his philosophical reasoning regarding these relationships, which led him to find in the rocks the ancestors of many creatures now living on this earth, and his contributions to the great and newly-developed science of evolution, are so well known that I need only name them to at once remind you

who have entered on that subject how much science owes to Huxley. But Huxley was not a man who was only a specialist, simply content to investigate his special subject in the complete and thorough manner which characterised all his work. From the very beginning he had a mind that must extend into philosophic thought. His moral lessons from his biological work extended even into the field of politics, and his contributions to thought in respect of theology, in themselves are such as to put Huxley's name and fame in a very high position indeed, as a man thoroughly determined to give all the benefit he could to mankind. As a worker who gives his life, who sacrifices his health, who sacrifices his time, who gives up everything for the advancement of science; but, as he tells us himself, with an object which he felt to be even greater than the advancement of science, the promotion of the welfare, moral and material, of mankind: who deserves a memorial or a monument better than Huxley?

The Right Hon. A. J. Balfour, M.P., in seconding the resolution, said:—

I gladly welcome the opportunity which the managers of this meeting have given me of lending such support as I can to the proposals that have been laid before you, for Prof. Huxley was a man who had many titles to our gratitude. I need not dwell upon what your Chairman has said with regard to Prof. Huxley's services as a teacher, or to the services he constantly gave to the Government of the day in lending his great talents to any investigations that were required of him. But putting all these relatively subordinate matters out of mind, Prof. Huxley, as a man of letters, and as a man of science, surely deserves from his fellow countrymen some permanent memorial. Every one whom I am addressing is probably well acquainted with those works which, quite apart from the matter which they contained, have earned for their author the reputation of being a master of clear, lucid, and vigorous exposition, not easily to be matched in the whole gallery of our literature. Lord Kelvin, in the observations which he has just made to you, and others far more qualified than I am to speak on such subjects, who will address you before the meeting closes, will give some indications of the great extent of the scientific labours and discoveries which will always be associated with Prof. Huxley's name. For my own part, however, if I were to try to choose among the many titles to our gratitude which he possesses, I am not sure that I should seek for it either in his literary performances, distinguished though they were, or in the series of scientific discoveries which have given him so distinguished a place among English biologists. It appears to me that Prof. Huxley has another claim, at least as great upon the gratitude of those who were born in the generation subsequent to that of Darwin. I take it that the great scientific fact of the latter half of the nineteenth century is the establishment of the doctrine of Evolution upon a scientific basis. I do not pretend to say for a moment, that in his labours in that direction, Prof. Huxley could be put upon a level with the great scientific originator of the doctrine of the Origin of Species, or with a very different and very eminent man—Mr. Herbert Spencer, who occupies so remarkable a position upon the borderland between science and philosophy. But this, I think, may truly be said, that in the critical period of scientific history which followed the publication of the "Origin of Species" in 1857, the man who did, perhaps, more than any other to stimulate public interest in the subject, to bring into line all the younger scientific thinkers of the day, to inspire them with his ardour, and with his convictions, was, probably, Prof. Huxley. That is no small title to fame. If it be the fact, that it is now the common privilege of all educated men to look at this material world in which we live, from the evolutionary standpoint, we owe it not merely to the great original investigators who started the theory, but to those who, like Prof. Huxley, did so much by their scientific discoveries to support it, or even more by their scientific preaching and their example, to spread it among all classes of their fellow countrymen. There were other questions never far absent from the mind of Prof. Huxley, as any one who knows his work will admit, as to which he has left few positive results, and concerning which differences of opinion exist; but there is, or there ought to be, no difference of opinion as to that great claim on our consideration which I have mentioned, and this, even if it stood alone, dissociated from his literary and strictly scientific work, it would, in my judgment, be quite sufficient ground for our using every exertion to carry into effect the resolution which it is my honour now to second.

Lord Playfair, in supporting the resolution, said:—

It is scarcely necessary to say one word in regard to the eminence and the scientific position of Prof. Huxley, but it has been my privilege to be associated with him in many of his undertakings and labours as a public man. I was a Professor with him in this Institution, and had the pleasure of having him as a colleague in many public inquiries and on various Royal Commissions for the benefit of the public. In higher education, the Scotch University Commission benefited by his wise counsel and breadth of culture. The present position of technical education also owes much to the advocacy and the scientific lectures which Prof. Huxley gave through the country. There is one labour in which to the time of his last illness, I had great pleasure in being associated with him—that was in the establishment of scientific scholarships of £150 a year in almost every college and university, not only in the United Kingdom, but in the Empire of India and throughout all our Colonies. That was a subject very dear to Prof. Huxley's heart, and although he was not much engaged in the executive part of it—which fell to my share as a Commissioner for the Exhibition of 1851—Huxley was a much-valued adviser in all matters relating to the establishment of these scholarships. They are all Research Scholarships, and are now exercising a benign and important influence over the science education of our great Empire. One whole autumn I had the pleasure of being in a gunboat with Prof. Huxley—being both on the Royal Commission for the examination into the fisheries of the British Coasts—and it is scarcely necessary to say he was a most active and valuable member of that Commission, both from his scientific knowledge and in estimating the value of the evidence of the fishermen in various parts of the fishery coasts of England. I do not, in speaking of his labours as a public man, wish to overrate them in comparison with his scientific work. On the contrary, I think discoveries in abstract science are of far greater importance to humanity than any labours performed for the particular generation in which the man lives. Still his public work had a great effect in making the name of Huxley popular and beloved by the people of this country; and we are entitled to ask the people for whom he has done so much in his generation—for he has left England better than he found it—to join us in making a memorial worthy of this great man whose memory is a possession dear to the country.

The resolution was then put to the meeting and carried unanimously.

Sir Joseph Hooker (Chairman of the Provisional Committee) moved the second resolution:—

"That the memorial do take the form of a statue, to be placed in the Museum of Natural History, and a medal in connection with the Royal College of Science, and that the surplus be devoted to the furtherance of biological science in some manner to be hereafter determined by the Committee, dependent upon the amount collected."

He said: As Chairman of the Provisional Committee, appointed to consider the question of a fitting testimonial to the great services to science and education of Mr. Huxley, I have the honour of saying a few words in regard to the result of its deliberations. Before doing this, you must allow me to express the singular honour I felt in being appointed to that position of Chairman, not only because of the great and important duty, but especially because of my great, long, and enduring affection and regard for Prof. Huxley. We both entered the public service as assistant surgeons and volunteer naturalists in the Royal Navy. Before Prof. Huxley went out in the *Rattlesnake*, the choice lay between us for the appointment to that vessel, and, fortunately, the choice fell upon him. Immediately upon his return a strong friendship sprang up between us, which has lasted forty-five years, throughout which he has been one of my staunchest and firmest friends. This friendship has affected me through life, and I owe a great deal of my success in scientific life to the advice, the stimulus, and the example which Prof. Huxley set me during a long career. After what has already been said by previous speakers, it would be a work of supererogation for me to go into any detail as to the great value of the services of Mr. Huxley, whether to science or education. You will be pleased to hear that these are appreciated, even more abroad than in this country: although if pleased in one sense, I

am afraid you will not feel satisfied in another. In a notice put into my hands by the Secretary, I find the Committee includes over 700 names; a special feature of it is the high percentage of acceptances from foreigners, which exceeds that from home sources, but I hope this state of things will be speedily remedied. Many of the foreign acceptances have been accompanied by letters expressing the highest admiration for Mr. Huxley, and good wishes for the success of the memorial.

With regard to the duties of the Provisional Committee, I need not say there were a great many proposals laid before them. It is unnecessary to go through these proposals, but they received the greatest attention. They may be grouped under four heads:

(1) A statue to occupy a public position.

(2) The founding of Exhibitions, Scholarships, and Medals for Biological Research, &c.

(3) The founding of Lectureships, &c.

(4) The republication of Prof. Huxley's Scientific Publications, in a collective form.

This last proposal has, I am glad to say, been partly met by a most liberal offer made by Messrs. Macmillan, who are prepared to publish, at their own risk, in a collective memorial form, the scientific papers of the late Mr. Huxley, now scattered over the publications of various learned societies and periodicals, provided that the size does not exceed two or three volumes of royal 8vo.; all we have to do being to appoint some one to supervise this invaluable series of papers. With regard to the memorial, the Committee decided to recommend that it should take the form of a statue and a medal, as now set forth in the resolution proposed.

Mr. Leslie Stephen, in seconding the resolution, said:—

I must preface the few words which I have to address to you, by saying that I had to overcome a certain degree of reluctance in addressing myself to you to-day—I did, however, overcome that feeling—because I feel that I am under the stress of a strong sense of personal gratitude to Prof. Huxley. I knew him for, I think, nearer forty than thirty years, and during our intercourse it happened, more than once, that he was able to show kindness to me on occasions in which kindness is doubly valuable, and on which one acquires a considerable degree of power of discriminating between merely conventional courtesy, and the outpourings of a warm, cordial heart. One of these occasions happened only recently; and I have so keen a recollection of Huxley's kindness and cordial sympathy, that I could not refuse to come here to say a few words to-day. I know that I am only saying what is felt by all who knew him, that he was a man who was not only to be honoured for his intellectual power, but to be loved for his masculine and affectionate nature. But qualities of that kind are happily not so rare as to demand any public testimonial. Only when they are combined with others, it is not merely a duty, but a privilege to seize any occasion of paying what honour we can to their possessor. I will not, however, dwell upon them; and, still less, upon those claims of Huxley as an advancer of science, of which there are other incomparably superior witnesses present. There is one point on which I, perhaps, may say a word or two without presumption. I have had the misfortune to be compelled to devote the greatest part of my energies to books, and only to see facts through the distorting medium of literature. It fell to my lot lately to read through the collected works of Prof. Huxley, and when I came to the end I felt a conviction—which Mr. Balfour has already expressed—that when the history of his time comes to be written, Prof. Huxley will find a place not only among the leaders in the most characteristic movement of the time, but also as one of the very first writers of English. There are certain reasons, perhaps, why his claims in that capacity may not be acknowledged so quickly as they ought to be by the ordinary critic. Nobody, of course, can read his lectures without admiring the force and vigour of the great intellectual gladiator. One feels of his style what I remember Hosea Biglow says, in a different connection, that—"for putting in a downright lick betwixt the eyes of humbug, none could match it." But then the critic of the present day is apt to take account only of what he calls "form," and not to attend and to dwell upon the more evanescent and indirect, intangible facts of literature; he is apt to think that the facts state themselves, that the thing is so clear it does not want any particular skill to work it out. The argument, when it is set going, seems to evolve of its own accord, and then he criticises in the style of the famous gentleman, who said, of some great work, "I could have written it myself, if I had only had a mind to." The obvious retort was—"it was just *mind* that was wanted." And what a style like Prof. Huxley's—which calls no attention to itself, but just sets the argument plainly before it—what that shows is certainly the possession, in the first place, of a clear, logical understanding, which always goes to the heart of matter; but it shows also, I think, some other great qualities. One cannot help observing the love of fair-play, which prevents him from ever striking a foul blow, and his loyalty to his friends, which gives a glow and warmth to his style, in standing up for such a man as Darwin for example; and besides that, the unflinching love of truth, the hatred of throwing dust in other people's eyes or letting it obscure his own, and, finally, what has been most truly noticed already, his strong preoccupation with the greatest and deepest problems of the time which, however they may be solved, whether in his sense or any other, require to be approached in a manly, serious spirit, as he always approached them. These, as I take it to be, very shortly are the mental and moral qualities which will give to Huxley's writings a place not only in science, but in the best kind of English literature, and in that faith it gives me the greatest pleasure to be allowed to have the honour of seconding this motion.

The resolution was then put and carried.

Mr. Alma Tadema moved the third resolution:—

"That the persons named in the list which has been circulated do form a General Committee, and that the following twenty persons be selected to form an Executive, with power to elect its own Chairman, and to add to the number of the General Committee:—

SIR W. BESANT.	SIR J. LISTER, BART., P.R.S.
SIR J. DONNELLY, K.C.B.	PROF. J. N. LOCKYER, C.B., F.R.S.
SIR J. EVANS, K.C.B., F.R.S.	LORD RAYLEIGH, F.R.S.
SIR J. FAYRER, K.C.S.I., F.R.S.	MR. BRITON RIVIERE, R.A.
SIR W. H. FLOWER, K.C.B., F.R.S.	DR. P. L. SCLATER, F.R.S.
PROF. M. FOSTER, F.R.S.	LORD SHAND.
PROF. E. FRANKLAND, F.R.S.	SIR H. THOMPSON.
SIR A. GEIKIE, F.R.S.	MR. SPENCER WALPOLE.
SIR J. HOOKER, K.C.S.I., F.R.S.	THE RIGHT HON. SIR J. LUBBOCK, BART., M.P., K.C.B., F.R.S., *Hon. Treasurer.*
PROF. E. RAY LANKESTER, F.R.S.	PROF. G. B. HOWES, *Hon. Secretary.*"

He said:—It would be presumptuous in me, a painter, after all you have heard and all you know about the departed friend, to say any more to you as to why humanity owes so much to that giant of science. But you know that, in England, science and art are merged together. We have our department, and so I have a certain right to say a few words. As it has been already so rightly remarked, Prof. Huxley was a man of innate worth and energy: when you were in his presence you felt as if you were sitting in the sunshine, and sunshine is the life of an artist. Besides that, he loved art, and art flowed in his blood, as you know so well, because one of his daughters was a first-class artist.

Sir Andrew Noble seconded the resolution, which was carried unanimously.

Prof. G. B. Howes (Joint Honorary Secretary of the Provisional Committee) announced that the sum already received in donations to the memorial was £213, and that £344 more was promised, making a total of £557. The donations included £100 from Andrew Carnegie, Esq.; £100 from J. Allsop, Esq.; and £50 from the Marquis of Salisbury.

Sir John Evans proposed that a hearty vote of thanks be given to his Grace the Duke of Devonshire for his kindness in presiding at the meeting.

Sir J. Fayrer seconded the resolution, which was carried unanimously.

The Duke of Devonshire, in reply, said:—I can only say I am very much indebted to you for the cordial vote of thanks you have been so good as to pass to me. I need not repeat what I said in opening these proceedings—that I feel as fully as any one present can possibly do how entirely deficient I am in any claims of a personal character to occupy the distinguished position for which I have been selected. I think, however, it is perfectly right that some member of the present Government of the country should be associated with a movement of such national interest and importance as the present one, and I am aware that, as the Minister

who is responsible for the Education Department of Government, I am, perhaps, officially designated for this position. I need hardly say that I shall find it somewhat difficult to give very constant attention to the duties which will devolve upon the Committee. I trust, however, that the General Committee will be relieved of any work of a detailed character by the Executive Committee which you have just appointed. However, I can only assure you that any further services which I am able to give to this cause will be very cheerfully rendered, and I think I may conclude by congratulating you on the character of the proceedings which have taken place this afternoon. I assure you I feel it a very high honour indeed to have been permitted to preside on such an occasion, and over a meeting containing so many distinguished persons as those who have assembled here this afternoon.

The meeting then adjourned.

Since the meeting of the General Committee, two meetings of the Executive Committee have been held. At the first of these, at which Lord Shand accepted the office of chairman, it was reported that a number of foreigners of eminence had expressed a wish to be associated with the proposal to commemorate Mr. Huxley's distinguished services to humanity. It was resolved, in the first instance, to invite subscriptions from the members of the General Committee. At the second meeting, held on Wednesday last, it was reported that the subscriptions, which at the general meeting had amounted to £557, had been increased to about £1400, and it was resolved that a wider appeal for subscriptions should now be made to the friends and admirers of Mr. Huxley amongst the general public. The Honorary Secretary stated that in America committees were in the course of being formed to promote the realisation of an adequate Fund. The Committee resolved to communicate, by means of a Sub-Committee of their number, with Mr. Onslow Ford, R.A., who had the advantage of being well acquainted with Mr. Huxley, in reference to the statue, which it is proposed should be erected beside those of Darwin and Owen in the Natural History Museum, South Kensington. The extent to which the Committee may be able to carry out the other intended objects of founding exhibitions, scholarships, and medals for biological research and lectureships, and possibly in assisting the republication of Mr. Huxley's scientific works, will of course depend on the subscriptions which may now be received. These may be sent to the Treasurer, Sir John Lubbock, or the Bankers, Messrs. Robarts, Lubbock, and Co., 15 Lombard-street, E.C.; or to the Secretary, Prof. G. B. Howes, Royal College of Science, South Kensington.

The amount received to December 20 was £1535.

The court of the Fishmongers' Company, in consideration of the eminent and important services rendered by Huxley to the cause of technical education, has agreed to give a scholarship of £60 per annum to the City and Guilds of London Technical College, Finsbury, to be called "the Fishmongers' Company's Huxley Scholarship," to be held for three years by any scholar who has given evidence of high scientific attainments, to enable him to proceed to the Central College at Kensington.

RELATIONS OF THE WEATHER BUREAU TO THE SCIENCE AND INDUSTRY OF THE UNITED STATES.[1]

IT is a matter of much pleasure to me that I am allowed the privilege of speaking at a joint session of this Association—representing as it does within the confines of its admirable organisation the scientific thought of our country. This is the Mecca towards which annually journey all those who wish, each to contribute his mite to the sum of human knowledge; each inspired with an ambition to add even one flickering ray to the great luminous orb which to-day is shedding the benign light of wisdom even unto the uttermost recesses of the earth; subduing the barbarous instincts of man, and warming and invigorating into life the better impulses of his nature. Thus is civilisation advanced, and thus is humanity elevated to higher and higher planes of existence.

I hope to be a worker in the ranks of this great army, and as the science of meteorology can hardly be said to have passed beyond the embryonic state, I feel that the realms of investigation are boundless, and that the opportunities are correspondingly great.

As the Chief of the greatest meteorological system in the world, and with the power to control, under the direction of the Secretary of Agriculture, not only its executive functions, but the lines of future scientific investigation, I fully realise the great responsibility that rests upon me, and that at the bar of public and scientific opinion I shall, in the years to come, justly be held to a strict accountability for my stewardship.

Before considering the lines of investigation which can consistently be prosecuted by the Weather Bureau, it will be well to note the law which perscribes the duties of the Chief.

By an Act Congress approved October 1, 1890, Sec. 3, Statutes at large, Fifty-first Congress, p. 653, it is provided:

"That the Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, on and after July 1, 1891, shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce and navigation, the gauging and reporting of rivers, the maintenance and operation of sea-coast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rainfall conditions for the cotton interests, the display of frost and cold wave signals, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties."

It will be seen that the main object for the existence and continuation of this Bureau is to give warning of the approach of storms, and therefore that the proper line of investigation should be for the purpose of determining the true philosophy of storms. The goal to be striven for is the improvement of weather forecasts, and surely one of the pre-requisites to determine coming events is a thorough knowledge of existing conditions.

To those who have read every important treatise on meteorology, and who have studied every text-book on the subject, it is painfully patent that we are extremely ignorant of the mechanism of storms, of the operations of those vast and subtle forces in free air which give inception to the storm, and which supply the energy necessary to accelerate cyclonic action when formed, or to disperse the same when fully in operation. We know that great atmospheric swirls in the shape of high and low pressure areas alternately drift across the country at intervals of two or three days; that the atmosphere flows spirally into the cyclonic or low-pressure system and outward from the anti-cyclonic or high-pressure system, that the in-drawn east and south winds on the front of the storm are warm, and that the inwardly-flowing north and west winds are cold.

The theories of Redfield, Espy, Loomis, Ferrel, and others, teach that our great storms are composed of immense masses of air gyrating about a vertical or nearly vertical axis, drifting eastward, and at the same time drawing in warm easterly currents at the front, and cold westerly currents at the rear; that the commingling of these two as they rise to greater and greater elevations, near the regions of the cyclonic centre, throws down volumes of rain or snow; that as precipitation occurs with the ascending currents, the heat of condensation energises the cyclonic circulation; that the air at the centre of the storm is relatively warm, is rarefied by centrifugal force, and by reason of less density, rises to a great elevation, and in the upper regions of the atmosphere flows away laterally to assist in building up high-pressure areas on either side.

The high and low pressure areas are supposed to be carried eastward by the general easterly drift of the atmosphere in the middle latitudes, somewhat as eddies are carried along by water in a running stream.

But, unfortunately for the complete accuracy of these theories, the forecaster often finds heavy downpours of rain without any cyclonic circulation, and no convectional system in operation; again over immense areas of country, especially in the Rocky Mountain region, for many months in the year condensation occurs not at all in the warmer easterly currents flowing into the storm centre, but almost exclusively in the westerly portion of the storm area, where the cold north and west winds are flowing in.

Again, many investigators to-day have good reason to doubt

[1] Read before the American Association for the Advancement of Science, at the Springfield Meeting, by Prof. W. S. Moore, Chief of the U.S. Weather Bureau. (Reprinted from *Science*.)

that the centre of the storm is warm to any great elevation, or that cyclonic circulation obtains to the top of the air.

In outlining, in a rough and general way, the line of investigation which in my judgment promises to give the most prolific results, not only to the cause of meteorological science, but to the making of more accurate forecasts for the benefit of agriculture and commerce, I will say that we have been for years taking our measurements at the bottom of this great ocean of air, while the forces which cause the formation of storms, and which influence their intensity and direction of motion, operate at great elevations, or are extraneous to our earth. It therefore seems imperative that systematic exploration should be made of the upper air. Balloon ascensions should be made in the several quadrants of the cyclonic storm, and also at the centre thereof, especially when rain is falling and the barometric gradient is steep. It is especially important to know the level at which condensation ceases, the depth of the cloud stratum, the temperature gradient, the air pressure and humidity, to a height of four or five miles. Skilled aëronauts with complete and accurate instruments should be placed in the region of severest action at the season of the year when storms are most frequent. They should be held in readiness until the approach of storms typical of cyclonic action, and then from the central office, where the movement of the storm is being carefully watched on the daily synoptic chart, they should be given telegraphic orders to ascend, and their ascensions should be so timed as to secure accurate readings at great elevations throughout the several quarters of the storm. It is believed that information thus secured will establish something like an approach to the true philosophy of storms, in contradistiction to the very imperfect theories which too often are hastily approved as demonstrated principles. Instead of erecting a cumbersome superstructure upon the sand, let us endeavour to lay a corner-stone upon which to erect something exact enough to be called a science.

In winter the great high-pressure areas which constitute our cold waves should receive the same thorough exploration. Readings at Pike's Peak or Mount Rainier might be useful in this investigation, but they are too far removed from the general track of storms and cold waves to furnish the full information desired.

Upper-air explorations may be accomplished by a train of kites carrying automatic instruments, by captive kite-balloons which may be forced nearer and nearer the zenith with increasing wind velocity, or by the ascension of trained observers in free balloons. We must strive for the perfection of appliances and instruments which will, at no distant day, enable us to present to the forecaster the charted synchronous meteorological conditions prevailing at high levels and covering a great area. Mr. McAdie, at Washington, has secured recently some good records with kites at elevations from 1000 to 2000 feet.

Systematic exploration of the upper air, with a continuation of the studies begun by Prof. Bigelow of terrestrial magnetic forces as induced by the solar magnetic field, will be the line of investigation prosecuted during the next two years, and from which it is hoped that results satisfactory to the practical as well as the theoretical man may be obtained.

The Secretary of Agriculture is in thorough sympathy with all lines of research which can be legally carried on under the Act of Congress constituting the Weather Bureau, and which promise to give results useful to the people.

Harmonious co-operation between the practical worker and the scientific investigator is essential to success. Too often they have found themselves picking out diverging paths. In the future they will work on parallel and converging lines, and not far removed from each other, and the result, I am confident, will be beneficial to all. In a great system like ours, each worker must be justly recognised for the merit that is in him, whether he be a skilled scientist or an able executive officer, and he should be given his proper place as an integral part of the great whole which constitutes the efficient Bureau.

A brief retrospect of the forecast work may not be without compensating results in our efforts at future improvements.

Forecasts were begun in the United States about twenty-five years ago, and have, during the past decade, become of such benefit to the many and diversified interests of the country that, with one accord, the people now acknowledge their value, and applaud all efforts to improve and extend their usefulness. Fifty million dollars is a low estimate of the value of property placed in jeopardy by one West Indian hurricane sweeping up our Atlantic coast

Predictions were first called "probabilities," and were made for districts, each comprising several States, and included a prediction as to the probable change in barometer. Later the prediction as to barometer was omitted. Forecasting by districts was soon shown not to be specific enough as to boundary, and the designations applied were not well understood by the people; hence forecasting by States was adopted.

Forecasts were made only at the Central Office at Washington, and the local observers were allowed to disseminate no other, nor to give public expression to any opinion of their own which might be construed into a forecast. Considering the very limited training of the observers, and the lack of all chartered meteorological conditions for their study and enlightenment, the wisdom of that regulation could hardly be questioned.

With the transfer of the Weather Bureau to the Department of Agriculture, came the inauguration of far more liberal and progressive ideas. The office of Local Forecast Official was created for such observers as had shown special fitness for forecast work, and they were assigned to duty at the more important agricultural, commercial, or maritime centres, with instructions to carefully study the local climatology of their sections, so that products that are indigenous to limited areas, or interests which are of special importance to particular sections, might have such application of the weather forecasts as the intimate personal attentions of a competent local official could give.

The changes enumerated have been carefully tested and found to be beneficent in purpose, and worthy of continued and permanent application. Thus has the forecasting system of to-day slowly developed during the past twenty-five years. Is it not the essential feature of the Weather Bureau? Is it not the nucleus around which all departments of thought and study must rotate and become auxiliary, if the original intent of Congress, made manifest by the establishment of a national storm-warning system, is to be carried forward to as successful an operation as the present knowledge of the physics of the air will permit? It is hoped that discoveries may be made relative to the controlling and modifying forces of storms which shall raise the standard of forecasting accuracy attained by our most expert officials, who have had all the benefits to be derived from many years of patient and intelligent observation of storms, from the time of their inception in, or entrance within our daily observed and charted territory, until they have been dissipated or have passed eastward beyond our range of vision.

It may be well to consider what class of forecasts can be most successfully made by our more or less empirical methods, the object being to extend the work along such lines of activity as promise the most beneficial results.

As to this proposition it is doubtless conceded by all that when pronounced high and low-pressure areas dominate the weather conditions and the changes in wind, temperature and weather are characterised by such force and degree as to render them destructive to lives and property, a forecaster of average ability and well-balanced judgment is able to make nearly or quite as accurate a forecast as when the air pressure is quite uniformly distributed and all changes of weather are so slight as to be of no importance.

If, then, a destructive frost or cold wave can be predicted as easily as a change of a few degrees in temperature, and if the coming of high winds and gales are as easily foretold as that of a gentle zephyr, it is evident which class of forecasts should receive the greater attention. The public care comparatively little for predictions of moderate changes, and but little credit attaches to the Bureau when such forecasts are verified; but when great heat, cold waves or violent winds are on the programme, a vital interest is felt in the subject, and the accurate forecasting of such conditions is the gauge by which the public measures the usefulness of the Bureau.

Horticulturists and the growers of tobacco and cranberries realise the vast benefit to be derived from accurate frost predictions, and I will give a brief statement of what I believe to be original ideas introduced into the making of frost forecasts while in charge of the State Weather Service of Wisconsin, a State including within its domain the largest area of cranberry marshes in the world, and also including an extensive area devoted to the cultivation of tobacco. Heretofore I believe that only the air conditions have been taken into consideration in the making of frost forecasts—such as pressure, temperature, relative humidity, cloudiness, and wind velocity. As a result of my investigations, systematically prosecuted for three years, I found that the conditions of the soil were equally as important as those of the air.

When the high-pressure area is moving in from the west, clear and colder weather anticipated, with the probability that the early morning temperature will permit the formation of frost—the most important elements to be considered, in determining whether or not frost will occur injurious to growing crops—are as follows:

(1) Has rain recently fallen, and what is the condition of the soil relative to the amount of moisture contained?

(2) What are the natural properties of the soil relative to the slow or rapid loss of heat by radiation?

(3) To what degree of heat has vegetation been subjected during the period immediately preceding?

The early fall frost injurious to tender crops occurs with the observed town or telegraph minimum temperature ranging from 40° to 50°, because, when the early morning temperature in the town falls much lower than 40°, it is usually so late in the season that all crops are gathered, or, if not gathered, they have been destroyed ere this condition arrives. At the time, then, that frost-warnings are of the most benefit, we have to deal with the air at temperatures considerably above the freezing-point, and to recall that a deposition of frost requires that the temperature of the top soil, or that of vegetation, be reduced to the freezing point. This, of course, is accomplished by conduction and radiation of heat, which takes place more rapidly from the soil and vegetation than it does from the lower stratum of air to the higher.

Anything that will seriously interfere with a rapid loss of heat after nightfall will tend to prevent the formation of frost. Moisture does this, and if the soil be well charged it partakes greatly of the stability of water as to temperature, and cools but little, if any, below the temperature of the superincumbent air, and no frost will occur even though all other favourable conditions of clearness, gentle winds, and cool air obtain. Even a small amount of moisture, say one-half inch of rainfall, will give ample protection if well distributed and precipitated within the twenty-four hours previous. But when severe drought conditions are prevalent, injurious frosts may occur when the telegraphic temperatures do not show a reading within ten degrees as low as in the first case.

I believe that, when estimating the probability or severity of frost, sufficient weight has not been given to the dryness or wetness of the soil, and the resultant dissipation or conservation of heat, and I call special attention to the point as one of the means for improving the forecast.

I have in mind two typical cases. In the first a high-pressure area attended by clear and cool weather drifted from the westward until it covered the State. No rain had fallen with the passage of the low-pressure area immediately preceding it; hence the ground was in excellent condition for the rapid loss of heat during the night, and a consequent lowering of the temperature of vegetation to the freezing point. Considerable damage was done to cranberries in unflooded marshes. In the second case a high-pressure area of slightly greater weight and slightly lower temperature covered the region about ten days later, but it was preceded within a few hours by a light but well-distributed fall of rain, averaging about one-half an inch, and no frost occurred. In both cases the wind was gentle from the north-west, and the nights were clear. With slightly lower air temperature and higher barometer in the second condition, heavier frost would have occurred than in the preceding case, had it not been for the thinly spread moisture of the timely rain conserving heat at the surface of the earth.

Might not this principle be carried further in the improvement of the forecast? Assuming that the caloric energy of the sun is a constant factor, the earth receives each year the same amount or intensity of heat, and as the atmosphere is warmed mainly by contact with or radiation from the earth, seasonal variations of temperature which are marked departures from the normal might result from abnormal terrestrial surface conditions with respect to the conservation of this constant solar energy over large continental areas. Here the excessive or deficient rainfall during the preceding seasons should receive careful consideration. The subject is one that requires deeper and more detailed investigation than the length of this paper will permit.

I find that the minimum temperatures in cranberry marshes during abnormally dry seasons often fall 15° below the temperatures telegraphed from the cities and towns within a few miles of the marshes. This is due to the fact that when the loose, spongy peat, of which the marsh is composed to the depth of several feet, has dried out, the radiation of heat during the night is very rapid, and is not counterbalanced by conduction and connection from the marsh. The temperature, therefore, in cranberry marshes is at all times much lower than that which obtains in marshes composed of heavy black muck, where it preserves a more equable condition, such as is common to air resting over a considerable body of water. A dry cranberry marsh does not, therefore, enjoy that immunity from frost enjoyed by wet marshes and watery lands. But when the ditches are flooded from the reserve water supply on receipt of a frost warning, the water quickly percolates through the peat composing the marsh, and the rapid loss of heat by radiation is checked and the frost averted.

The amount of heat to which vegetation has been subjected immediately before the frost condition, and the temperature under which it had made its growth, will in a great measure determine the extent of damage to ensue.

By carefully considering the principles herein enunciated, I will say that in 1894, twelve out of fourteen official forecasts of frost were fully verified—a much greater percentage of accuracy than has ever been attained by simply considering air conditions alone.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ON Friday, the Chancellor of the Exchequer received at the Treasury a large deputation in support of a memorial praying that increased aid may be given to the English University Colleges, ten in number, and to University College, Dundee, which at present receive among them an annual grant of £15,000. Sir M. Hicks Beach, in reply, said there was no question that the existing grant of £15,000 would be continued; but he thought that in accordance with the recommendations of two Parliamentary committees a competent inspector should be appointed to visit annually each college receiving a grant, and report on its efficiency, its success, and its financial position. Till such an inspector should have reported, he did not think it possible for him to consider the increase of the grant.

IT is satisfactory to be able to note that the question of the education of mine managers, assayers, and engineers in Australia is actively discussed in the most recent Government reports on mines for several of the Colonies. In Victoria, mining schools have long been established at Ballarat and Bendigo, with branches at the more important mining centres in the Colony. Certificates of competency to act as mine managers are given by these schools, although the holding of such by mining engineers is not compulsory by law. In like manner in Tasmania, similar certificates are given after a Governmental examination. As the Under-Secretary for Mines of Queensland observes in his latest annual report, "the implication is that a certificated mining manager is preferable in the eye of the law to one who has no such credentials." In 1893 a school of mines in connection with Sydney University was founded by the New South Wales Government, and £10,000 spent in the erection of a suitable building, which has just been completed. The teaching staff has been formed at a small cost by utilising the services of the professors paid by the University, and lectu es and practical instruction are now being given in chemistry, metallurgy, assaying, geology, mineralogy, and all branches of mining to an increasing number of students. Up to the present Queensland alone, among the more important Colonies, has established no mining school; but, State aid having been p omised to well-supported schemes in any mining centre, the reproach will probably soon be removed. Indeed, some progress has already been made towards establishing a technical school at Brisbane. With regard to the effect of such schools, the Under-Secretary of Mines for New South Wales remarks, in his Report for 1894: "It is hoped that the establishment of the School of Mines will result in the gradual improvement in the methods of mining, as practised in this Colony, by providing a class of managers who will have had the advantage of a thorough scientific training, and who will only need a few years' practical experience to qualify them as mining engineers of the highest efficiency. The ultimate result must be an increased development in the mining industries of this country." In view of this feeling on the part of the Government officials of the various Colonies, it is evident that the compulsory possession of a certificate of competency by Australian mine managers is almost within sight.

SCIENTIFIC SERIALS.

American Journal of Science, November.—On the wave-length of the D_3 helium line, by A. De Forest Palmer, jun. The definition and intensity of this line varied greatly from day to day. The best combination of intensity and definition was obtained by avoiding prominences and working only on very clear days. The average for seventeen series of measurements was 5875·939 ± ·006.—Some additional notes on argon and helium, by Edwin A. Hill. The conclusion that argon is monatomic depends upon the correctness of three assumptions, viz., that a gas, with little or no rotational energy, must be monatomic; that the ratio of the two specific heats of 1·67 proves the gas to have no rotational energy; and that the ratio of the two specific heats is correctly determined. In choosing between the two alternatives of a diatomic gas without rotational energy or a free atom devoid of chemical affinity, the presumption is strongly raised that it is not a monatomic gas, but diatomic and chemically inert because the two atoms of the molecule are very strongly bound together. There is not much doubt that helium is a mixture, and if anything can be argued from the analogies between argon and helium, argon is a mixture likewise.—Recent progress in optics, by W. Leconte Stevens. Part II. This concluding portion of the presidential address deals with colour photography, with recent researches on the spectrum and on polarised light, and with colour sensation.—Effect of the mutual replacement of manganese and iron on the optical properties of lithiophilite and triphylite, by S. L. Penfield and J. H. Pratt. The transition from $LiMnPO_4$ to $LiFePO_4$ is marked by a considerable change in the optical characters of these isomorphous minerals. With an increase in iron there is an increase in the indices of refraction, and also the divergence of the optical axes changes rapidly.—The reduction of selenic acid by hydrochloric acid, by F. A. Gooch and P. S. Evans, jun. A solution of selenic acid is boiled in hydrochloric acid, and if the solution is not too dilute the reduction is obtained in a few moments. The hydrochloric acid must form at least 30 per cent. of the entire solution. The solution should be boiled until all the chlorine is expelled, but must not be allowed to fall below two-thirds of its original volume.—Reduction of selenic acid by potassium bromide in acid solution, by F. A. Gooch and W. S. Scoville. When intermixed with sulphuric acid and potassium bromide, selenic acid liberates bromine in proportion to the excess of acid, the bromide, and the elevation of the temperature. On boiling, the bromine is evolved and may be collected in potassium iodide, and the iodine thus set free may be determined by standard sodium thiosulphate and taken as the measure of the bromine distilled.—Restoration of some European Dinosaurs, with suggestions as to their place among the Reptilia, by O. C. Marsh. The geological positions of *Compsognathus* and *Scelidosaurus* are fully determined, but that of *Hypsilophodon* and *Iguanodon* is not so clear. The latter are found in the Wealden, which is usually considered to be Cretaceous, but might as well be classified as Upper Jurassic.

The numbers of the *Journal of Botany* for November and December are chiefly occupied with papers on descriptive botany. Mr. D. Prain completes his account of the genus *Argemone*, and Herr R. Schlechter his *Asclepiadaceæ Elliotianæ*, and describes also two new genera of the order, from Madagascar and from Angola.

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 21.—"On the Gases obtained from the Mineral Eliasite." By J. Norman Lockyer, C.B., F.R.S. (Received August 6, 1895.)

Observations have been made of the gases obtained from the mineral eliasite heated *in vacuo*, in the manner which I have described in a former paper,[1] and, in addition to lines of known gases, others have been noted, for which no origins can be traced, at the following wave-lengths:—

Ångström.	Rowland.
6121·4	6122·4
6064·6	6065·7
5990·2	5991·2
5874·9	5875·9 (D_3)
5845·7	5846·7
5428·8	5429·8
5403·1	5404·1

[1] *Roy. Soc. Proc.*, vol. lviii. p. 68.

The wave-lengths of these lines have been determined by means of a Steinheil spectroscope having four prisms, comparisons being made with adjacent metallic lines, and the positions interpolated by micrometric measurements; the accuracy may perhaps be taken to be within 0·1 tenth metres. Other lines have been noted, but they are not included in the list, for the reason that their wave-lengths have not yet been determined with the dispersion stated above.

Of the lines in the foregoing list, six are in all probability coincident with chromospheric lines, as shown in the following table, which also indicates the frequencies and brightnesses of the lines according to Young:—

Wave-length of Chromospheric Lines.

(Angström's scale).	(Rowland's scale).	Frequency.	Brightness.
6121·2	6122·4	5	3
6064·5	6065·7	5	2
5990·0	5991·6	10	4
5874·9 (D_3)	5875·9	100	90
5428·8	5429·9	8	3
5403·1	5404·1	5	3

It is important to point out that all these lines do not appear in the spectrum at the same time. For instance, in the first two specimens of the mineral no trace of D_3 was noted, but in the third portion examined, all coming from the same specimen, D_3 appeared as a pretty bright line. Again, as in the case of a previous operation on bröggerite,[1] in one experiment with eliasite the products of distillation, collected in four stages, gave different spectra.

These facts seem to indicate that the gas obtained from eliasite is either a compound or a mixture of gases, just as is that obtained from bröggerite according to former experiments.

It is also to be remarked that among the lines in the eliasite spectrum, those at 6122·4 and 6065·7 have been recorded in the gases obtained from cleveite, and 6122·4 has also been noted in the gas obtained from gummite.

It seems to be more than probable, therefore, that the lines observed in eliasite indicate a new gas, in some way associated with those given off by cleveite and bröggerite, and the fact that D_3 is not necessarily present in the spectrum, furnishes an additional argument in favour of the view that the gas obtained from cleveite or bröggerite is complex.

Addendum. Received November 18.

The results in the foregoing paper depend upon eye observations on the red end of the spectrum. Since it was communicated to the Society the blue end has been investigated photographically. Many specimens of eliasite have been distilled, and numerous photographs of the spectra of the gases given off have been taken.

The work has been rendered difficult by the very small quantity of what I believe to be a new gas, and the large quantity of carbonic acid, nitrogen, and hydrogen given off from the mineral. Attempts have been made to get rid of the known gases, in order to make the lines in the new gas better visible, and then the amount of gas was in most cases very small and at times admixed with argon produced by the sparking.

The photographs have been measured and reduced, and it is probable that the lines, or some of them, which cannot be ascribed to any known gases, may belong to the same gas as that giving the lines observed in the red. I append a table of some of these lines, which suggest possible coincidences in stellar and solar spectra; the numbers in brackets indicate the intensities of the lines, 6 being the maximum in the case of α Cygni, and 10 the maximum in the case of the eclipse spectrum.

Wave-lengths (Rowland).	Coincidences.
3961·4	α Cygni (6)
4035·2	Eclipse (2)
4058·6	,, (1)
4128·3	α Cygni (3)
4131·4	,, (3)
4224·0	Eclipse (1)
4255·7	,, (1)
4442·5	,, (3)

[1] *Roy. Soc. Proc.*, vol. lviii. p. 194.

In addition to the above lines there are others with which no celestial coincidences have been traced.

Some of the unknown lines at first noted in the red have been observed again in the gases obtained from other specimens; it is important to note that remarkable variations in the spectra have been observed in passing from one specimen to another.

Although the evidence in favour of a new gas is already very strong, no final verdict can be given until the spectra of all the known gases, including argon, have been photographed at atmospheric pressure and the lines tabulated. This part of the inquiry is well in hand.

November 28.—" Examination of Gases from certain Mineral Waters." By Alexander Kellas and Prof. William Ramsay, F.R.S.

A sample of gas of an inflammable nature from " Allhusen's Well," Middlesbrough, was tested for argon. The usual constituents, nitrogen, hydrocarbons, &c., were removed by the usual absorbents, magnesium, copper oxide, &c., and finally by sparking with oxygen over caustic soda. The spectrum of the residue was carefully compared with that of argon, and the lines were all found to be coincident. No new lines appeared, nor was any helium yellow visible. An incombustible gas from another well at the same place was also tested, and was found to contain 0·5 per cent of argon.

Some gas from a boiling spring near Reykjavik, Iceland, was found to contain a greater proportion of argon than is present in air, viz. 1·14 per cent. No helium could be detected in the gas, nor were there any lines which could not be recognised as belonging to argon.

" On the Percentage of Argon in atmospheric and in respired Air." By Alexander Kellas.

Experiments were made on the comparative amount of argon in ordinary air, and in air which had been frequently breathed, with the view of ascertaining whether, if the proportion of oxygen and carbon dioxide in air be very much altered, argon would either enter into, or be expelled from, the respiratory system. The experiments show that the proportion of argon to nitrogen remains nearly normal, even when the air has been greatly altered in composition by respiration.

From the experimental results it appears that 100 c.c. of nitrogen and argon of breathed air contains 1·210 c.c. of argon. This percentage is larger than that in normal air. One of two suppositions may be made: either the increased amount is due to the air having been confined over water during breathing, or argon is given off from blood in greater amount than it is absorbed, when the composition of the air in the lungs is so much altered; the former appears the more probable supposition. In any case the difference is not great; and it would appear that argon, like free nitrogen, plays no important part in the animal economy, save as a diluent.

Linnean Society, November 21.—Mr. J. G. Baker, F.R.S., Vice-President, in the chair.—His Grace the Duke of Bedford, Messrs. Bernard Arnold and E. B. Fernan were elected Fellows of the Society. Mr. B. B. Woodward was admitted.—The Rev. G. Henslow exhibited a MS. common-place book of the latter end of the fourteenth century. The entries in Latin and English were found to consist chiefly of medical recipes in which about 200 plants are named for their user, and some methods of distilling *Aquæ vitæ* described. In addition were some notes on geometry and astronomy, and calculations of altitudes and superficies. Mr. Baker thought the number of plants named at the date referred to was a matter of some interest to botanists, and suggested publication of the list of names with their identification where possible.—Mr. Henslow also exhibited a series of shells of *Buccinum undatum* and *Fusus antiquus*, showing the variation in form which occurs in the reparation of injury sustained at an early stage of life, the subsequently renewed whorls assuming shapes resembling those of other species in the same genus, and even in other and very different genera. Usually the uninjured whorls could be detected by the apex being of the normal character; but in some cases the abnormality appeared to be congenital, being carried completely into the ape. This raised the question whether these were acquired characters and hereditary, having been impressed upon the offspring born after the parent shell had been injured, and renewed by growth. Mr. E. R. Sykes and Mr. B. B. Woodward offered some criticism in the discussion which followed, and deprecated the suggestion of anything like " mimicry," the resemblances in question being regarded as purely accidental.—Mr. T. H. Buffham exhibited lantern slides of a red marine alga, *Bonnemaisonia hamifera*, Hariot, found floating in the sea at Falmouth. This species, recorded previously only from Japan, bears thickened branches terminating in a hook (hence the specific name), in this respect resembling *B. californica*, Buffham, which was also shown. Various microscopic characters of each were described and compared with those of *B. asparagoides*, Ag. It was suggested that if *B. hamifera* had been introduced from Japan, it could only have been from spores, or possibly the hamose branches might develop into plants, since the Falmouth specimens were quite fresh, and must have been living near the place of discovery.—Remarks on the mode of distribution of algæ were made by Mr. George Murray and Mr. E. A. Butters.—Dr. D. Morris, C.M.G., read a paper on the development of a single seed in the fruit of the cocoanut palm (*Cocos nucifera*). Alluding to the occurrence of palms with twin and trifid stems arising from one base, it was shown that these were due (1) to several seeds in one fruit; (2) to more than one embryo in a seed; or (3) to a branching of the primary shoot. In cases cited by Rumphius, Forbes and others, several seeds were found in one fruit. The course of the development of the single cell was illustrated by means of lantern slides. The obliteration of the two cells began about the second or third week after the spathe was open. By the end of the seventh week they were reduced to narrow slits, which were still traceable in the mature fruit.—On behalf of Mr. A. J. Ewart, Prof. Harvey Gibson gave an abstract of a paper on assimilatory inhibition, the causes by which it may be induced, and their influence on vitality. It was shown that most inhibitory agencies operate by inhibiting the initial stages in assimilation, but any cause affecting the rapidity of removal of carbohydrates from assimilatory cells will also affect their power of assimilation, the commencement of which is determined mainly by the development of the chlorophyll pigment, but is also influenced by other indeterminate factors probably plasmatic in origin. The paper dealt mainly with the discussion of experiments with a large number of plants, and criticism of the results arrived at by other investigators. An interesting discussion followed, in which Dr. Scott, Prof. Reynolds Green, and Prof. Weiss took part.—Mr. A. C. Seward gave the substance of a paper on a new species of *Pinites* from the Wealden (England).

The Institution of Civil Engineers, December 17.—Sir Benjamin Baker, K.C.M.G., President, in the chair.—The design and testing of centrifugal fans, by Mr. H. Heenan and Mr. W. Gilbert. The object of the experiments recorded in this paper was to determine the best form of fan-blade and fan-case, and the most economical diameter and speed of a fan, to produce any required volume of air at a given pressure. The comparative output of fans of the same type, but differing in size, showed that, if they were run at the same tip-speed and produced the same water-gauge, the air-discharge would be proportional to the centre section of the fan, that was, to the diameter multiplied by the width. A series of tests made to determine the efficiency of an expanding chimney was also described. Air was passed from a fan through a delivery tube into an expanding chimney, the sides of which could be set at any desired angle to the centre line of the tube. The efficiency for any angle was obtained by dividing the vacuum observed at the throat of the chimney, by the calculated vacuum due to the reduction of velocity of the air as it passed from the inlet to the outlet of the chimney. The results of the tests showed that the angle on each side might be as much as 15° without loss of efficiency. The air speed recommended at the chimney outlet was 20 feet per second, and the efficiency with this speed varied between 0·43 for 6° opening, and 0·42 for 15° opening on each side.

Mineralogical Society, November 19.—Anniversary meeting.—Prof. N. S. Maskelyne, F.R.S., in the chair.—The following officers and members of Council were elected: President, Prof. N. S. Maskelyne, F.R.S.; Vice-Presidents, Rev. S. Haughton, F.R.S., Dr. Hugo Müller, F.R.S.; Treasurer, Mr. F. W. Rudler; Foreign Secretary, Prof. J. W. Judd, F.R.S.; General Secretary, Mr. L. Fletcher, F.R.S.; ordinary members of Council, Prof. Green, F.R.S., Mr. Harker, Prof. Lewis, Mr. Pringle, Mr. Prior, Mr. Thomson, Mr. Tutton, Mr. Watts, Prof. J. Geikie, F.R.S., Mr. Hutchinson, Mr. Kitto, Lieut.-General C. A. McMahon. Mr. J. H. Collins was elected an auditor in place of Mr. F. Rutley, resigned. The Rev. Mark Fletcher and Mr. R. C. Webb were elected members of the Society.—Mr. Wm. Barlow read a paper on homogeneous structures and the symmetrical partitioning of them, and

exhibited models, manufactured by himself, to illustrate the manner in which various types of cubic symmetry can be constructed from units composed of any material distributed in the least symmetrical manner compatible with the requirements of that system. The models were hollow cubes, each containing three small hands affixed to one diagonal, right hands in some cubes and left hands in others. The author insisted upon the desirability of regarding the problem as one of the homogeneous distribution of matter without any limitation as to the form of the units, herein placing himself in opposition to the recently expressed views of Fedorow, who regards parallelohedra as the basis of all crystalline structures.—Prof. A. S. Herschel exhibited a number of intricate coloured models, made by himself, to illustrate the symmetrical partitioning of space, and indicated the various ways in which they may be viewed as interpenetrating or juxtaposed compartments. In the discussion which followed, Mr. Tutton agreed with Mr. Barlow's conclusion that the space-units should not necessarily be endowed with the same symmetry as the whole solid, and suggested an analogy between the author's conception of a growth of the hands whereby they might meet and fill the space with close-packed units, and the growth in volume which may occur when one metal in a salt is replaced by a heavier one of the same series. The President observed that such space-partitioning surfaces are purely imaginary; their form and dimensions must vary with temperature-changes, &c. The morphology of crystals has had nothing to learn from the geometry of crystal tactics; on the other hand, it has corrected and guided the course of those geometrical inquiries. The future working-out of the relations of stereo-chemistry to morphology and to actics will give significance to the stereohedra and parallelohedra of Fedorow, and will perhaps explain the existence of planes of symmetry, a principle which underlies any true theory of crystal-structure.

PARIS.

Academy of Sciences, December 16.—M. Marey in the chair.—On a theorem in geometry, by M. J. Bertrand,—The composition of flour and other products of roller milling. This is an attempt to place the operation of milling upon a scientific basis. The products of the fining were separately weighed and analysed, and samples of bread made from each.—Observations on Brooks' comet (1895, November 21) made at the Paris Observatory, by M. G. Bigourdan.—Observation of a meteor, by M. G. Bigourdan. A very brilliant meteor seen 7h. 4m. 50s. p.m., December 15. It appeared to be moving very nearly horizontally at a height of 45° in the direction from east to west.—A new explanation of the phenomenon of the solar prominences, by M. J. Fényi.—The equation to derived partials with constant coefficients, and on non-analytical functions, by M. E. Borel.—On the rolling of two surfaces on each other, by M. E. Cosserat.—Measurement of the force acting on a non-electrified dielectric, placed in an electric field, by M. H. Pellat. An experimental proof of a theorem established in a previous note.—The direct combination of nitrogen with metals, by M. A. Rossel. It has been found that if an intimate mixture of finely-powdered calcium carbide with magnesium powder is heated with free access of air, the metal is almost completely transformed into the nitride. Finely divided aluminium, zinc, iron, and copper act similarly.—On the preparation and properties of crystallised chromous sulphide, by M. A. Mourlot. Metallic chromium was heated to a high temperature in a stream of sulphuretted hydrogen. The product proved to be the protosulphide, which on strongly heating was obtained in the crystalline state. A study of its behaviour towards a number of reagents showed that it is a compound of considerable stability.—On lithium subchloride, by M. Guntz. This is prepared by heating lithium and the ordinary chloride together to a red heat. The product decomposes water with the liberation of hydrogen.—On some new saffranines, by M. G. F. Jaubert.—Study on *Aspergillus orizæ*, by M. E. Sorel. It is shown that if cultures of the conidia in malt-wort are subjected to certain temperatures, and in presence of hydrofluoric acid, the mycelium first produced breaks down into a yeast-like form capable of isolation by repeated cultivation in malt-wort. This yeast is active, and whilst fermenting an ordinary malt solution produces no mycelium. The latter, however, can be reproduced again under special conditions, thus completing the life cycle.—Functional assimilation, by M. F. Le Dantec.—On the process of development in the Filigranes and Salmacynes, by M. A. Malaquin.—On the influence of electricity on the development of the embryo of the chicken, by M. C. Dareste.—Study of the effect of the colour of light upon vegetation, by M. C. Flammarion.—On some vegetable impressions in the coal-measures of Southern Brazil, by M. R. Zeiller.—A new disease in the leaves of the larch, by M. E. Mer.

NEW SOUTH WALES.

Linnean Society, October 30.—Mr. Henry Deane, President, in the chair.—On the occurrence of diatomaceous earth at the Warrumbungle Mountains, N.S.W., by Prof. T. W. Edgeworth David.—Jottings from the Biological Laboratory, Sydney University, No. 18.—On certain points in the structure of the pearly nautilus, by Prof. W. A. Haswell.—The grey gum of the North Coast districts (*Eucalyptus propinqua*, sp. nov.), by Henry Deane and J. H. Maiden. This grey gum has for many years held an uncertain botanical position, having been ranked, at different times, by botanists under *E. punctata*, *E. saligna*, and even *E. viminalis*. The authors believed that it but perpetuates the confusion to place it under any existing species. Its bark and timber considerably resemble those of *E. punctata*. From this species *E. propinqua* differs in the smaller size of the flower-buds and fruits; and in the narrow lanceolate leaves which also have more parallel and less prominent lateral veins than *E. punctata*. The calyx-tube and also the operculum of *E. propinqua* are more distinctly hemispherical, and its flowers more pedicellate. The fruit of *E. punctata*, though variable in size, is always larger and more cylindrical than that of *E. propinqua*. *E. propinqua* was fully described, and its affinities and differences from other species were further given in some detail. The species is found from the Hawkesbury River to the Tweed River, and probably will be found to extend to South Queensland.—On new localities for *Peripatus*, by Edgar R. Waite.

CONTENTS.

THURSDAY, JANUARY 2, 1896.

THE ALPS FROM END TO END.

The Alps from End to End. By Sir William Martin Conway. With 100 full-page illustrations by A. D. M'Cormick. Pp. xii + 397. (Westminster: Constable and Co., 1895.)

SIR WILLIAM CONWAY has given us in this new work a racy account of a three months' summer journey through the Alps from west to east. To a climber of Himalayan fame it was not much that the "Playground of Europe" had to offer in the way of enterprise or difficulty. Neither was it Sir William Conway's intention to combine scientific aims with his mountaineering feats in the Alps, as he had done in the Himalayas. The purpose he had in view was

"to devise a route . . . so that a climber might begin at one extremity of the snowy range, and walk up and down through its midst to the other extremity over a continuous series of peaks and passes" (p. 3).

The tour began at Turin, on June 1, 1894, and ended on August 26, at Gastein. Seven were of the party—Sir William Conway and Mr. E. A. FitzGerald, accompanied by three well-known "high tour" guides, Carrel, Zurbriggen, Aymonod, and two Gurkhas, Amar Sing and Karbir, who had been with Sir William Conway in his Himalayan journeys.

The first part of the route lay along the French-Italian frontier, traversing the Maritime, Cottian, and Graian Alps. The climbs here were not so successful as they might have been, owing to late snow on the mountains, general bad weather, and the occasional interference of the frontier gendarmerie. The narrative gives many amusing accounts of custom-house colloquies. We read of the "inquisitive Jack-in-office" and "suspicious lieutenants," and we sympathise with the would-be climbers waiting hours at Colle di Tenda for a colonel "who was either asleep or out," and at last sent a "ghostly captain" to assure the party of his distinguished consideration, but to announce that *this fortified circle of the hills was closed to all the world!* The author's keen sense of humour is seen to full advantage in those early chapters.

The first successful climb was that of Pelvo d'Elva, on June 8, followed on June 12 by the ascent of Monte Viso, both in the Cottian Alps. The cold must have been very intense.

"Some cold cream in FitzGerald's pocket was turned into a stony lump. Our knitted gloves were as stiff as boards. Icicles hung in rattling plenty from beards and moustachios . . . . " (p. 53).

Unfriendly weather pursued them into the Graian Alps, but on June 22 the Aig. de la Grande Sassière was climbed under favourable skies, and a glorious panorama rewarded them. They could see from the Maritimes in the south to Mont Blanc and the Swiss giants in the north. The photograph of the Sassière peak is a good representation of the broad slabs of slaty rock so characteristic of this region of the western Alps.

Very pleasantly written pages relate the journey from the Graians into the *Valais*, over the Col de St. Grat and down the Ruitor glacier to La Thuille. Sir William Conway writes:

"Assuredly nowhere else is Mont Blanc better seen than from this Ruitor névé. No foreground more admirably serves to set off its blue shadowing buttresses and cream-coloured domes than the flat white area of this magnificent snow-field" (p. 94).

The party was now in full training, and the glaciers and peaks of the Mont Blanc massif were attacked with extraordinary vigour. The reader is hurried through the grand natural gateway of Courmayeur, torn along the lovely Allée Blanche—where he is allowed to hear nothing but Aymonod's chatter, and to see little except two cowherds fighting and a background of glacier—then, after rapid climbing up the Miage glacier, he is given time for reflection in the Dôme Club-hut. The next day, too, when the summit is reached, the reader cannot but be disappointed that Sir William Conway so summarily dismisses the expected description of the view. Any one who has read Mr. Leslie Stephen's "Sunset on Mont Blanc," will feel the wide difference between the essayist who faces the difficulties of Mont Blanc because he is first and foremost a lover of nature, and the author who is steeped in professional climbing, and includes Mont Blanc in a record tour! We are glad that the continuation of the route was made over Col d'Emaney and the Salanfe Alp, for this region deserves to be better known amongst English travellers.

The most effectively written chapters in the book are those which follow, on the "Western Bernese Oberland." There the author strikes many wise notes of experience. For instance:

"All high mountains command fine views, but there are differences between them, both in kind and degree. I hold that on one side at least there should be green and fertile land. If a lake is visible, so much the better. The eye, too, should somewhere plunge into a profound valley. The great ranges should not spread themselves out like a procession, but should be grouped into masses. The Diablerets' view conforms to all those conditions" (p. 138).

Every one knows how the pleasant châlet-life helps to enhance and soften the scenery of the mountain pasturages between Lake Geneva and Lake Thun. Sir Willam Conway treats this part charmingly, and, thanks to the garrulous guide Aymonod, he acquaints the reader with many secrets of Swiss cheese-making.

A much sterner aspect of Swiss experience is presented in the chapter on Monte Rosa. The ascent was undertaken on this occasion by Sir William Conway entirely for the sake of the "reading public." A fearful gale blew on the mountain, and we question if charitable England will agree that the amount of enlightenment gained entirely justified the foolhardiness of the party of climbers and the frost-bitten toes of Amar Sing! The author writes in his enthusiasm:

"Such struggles with nature produce a moral invigoration of enduring value . . . They bring a man in contact with cold, stony reality, and call forth all that is best in his nature. They act as moral tonics. Of all the time I have spent in the mountains, such days as these have possessed upon the whole the most enduring value" (p. 174).

There is an unmistakable Cromwellian spirit about this.

The description of the journey through the eastern Bernese Oberland is inclined to be scrappy. It is here that the words "couloir" and "bergschrund" are explained for the first time in the book, although they have been in constant use by the author in the preceding 200 pages. Such flaws of orderly treatment frequently occur, and remind us that the narrative was originally written for a serial journal. The Alps of Uri and Glarus repeat the more pastoral scenes of the western Oberland, but the inhabitants are less kindly criticised.

The Austrian frontier was reached on August 1. The chief peaks ascended in Austria were the Scesa Plana in the Rhaetikon, the Weisskogl in the Oetzthal Mountains, the Hochpfeiler in the Zillerthal Mountains, the Gross Venediger, the Gross Glockner, the Klein Glockner, and the Ankogl Mountain. During the latter part of the journey, east of the Brenner Pass, Sir William Conway was accompanied only by the two Gurkhas. The departure of the others, especially the loss of Aymonod's talk, was not without its effect on the "Journal." Side-incident distributed itself around fellow-travellers, and the German and Austrian Club-huts received a large share of attention at the author's hands.

Taken as a whole, the "Alps from End to End" is a notable example of the fact that occasional papers published in a "serial" seldom cohere satisfactorily into an independent volume. As a literary production, the book is not likely to add to the author's fame. It is one which will live only in the form of extracts. Fine descriptive passages occur in plenty, but they are loosely padded together. Ideas are fragmentary, and repetitions tiresome. The state of the weather and the digestion of the party play naturally enough a most important part in a faithful journal of Alpine climbing, and if the journal be read by weekly instalments, those items may act pleasantly as a foil to the main interest of climbing. But it will try the patience of most readers to go through the variations of this theme, chapter after chapter, in a one-volume book. Still, the book contains a mass of useful hints and information for ardent Alpine climbers. The author conveniently condenses the details of each part of the route, and gives the time record, at the beginning of each chapter. These small summaries are admirable storehouses of reference for the practical walking tourist.

Every one, tourist or stay-at-home, will feel bound to admire the *sangfroid*, pluck, and determination which carried the author through an extremely difficult programme of climbs in all weathers. But the Alpine devotee will regret the business-like way in which the tour was accomplished, as well as the unsympathetic attitude often shown by the author towards the hard-wrought inhabitants of these high regions. Sir William Conway is at his best when he discusses views, peaks, cloudland, and the elements constituting a good panorama. Nothing could be neater, for example, than the following aphorism: "That panorama is the most perfect which the eye follows round with the greatest luxury of movement" (p. 348).

There is one feature in the book which cannot entirely be passed over. It is the author's touch of impatience with the familiar figure in the Tyrol—the German "Rücksack" tourist who carries his belongings on his back, and is his own guide. The same feeling is extended to many of the well-meant efforts of the German and Austrian Alpine Club for the aid and better enjoyment of such tourists.

"The Tirol is cursed with wire-ropes. Wherever a good scramble was offered by nature, it has been ruined in this fashion by man, with the result that any bumpkin can get conveyed almost anywhere in this mountain area" (p. 275).

Sir William Conway seems to forget what an enormous saving it is for hundreds of the less wealthy tourists to be able to climb mountains and cross cols safely without paying the tax levied by the guides. And that is what the step-cutting and path-making of the German and Austrian Club have made possible in their Alpine territory. On the other hand, an economical tour in the *Valais* is almost impossible. Care seems to be taken by the people there not to put up a single signboard for the guidance of the walking tourist! This certainly leaves nature's beauty unimpaired; but we fear it is the commercial instinct, and not the love of beauty, which rules the Swiss.

Little can be said of the numerous illustrations contributed by Mr. A. D. M'Cormick to Sir William Conway's book. They are drawn from photographs; but, although interesting, they lack the artistic freedom and cleverness which made the charm of Mr. M'Cormick's original sketches for "Climbing in the Himalayas."

THE ARCHEGONIATE SERIES OF CRYPTOGAMS.

The Structure and Development of the Mosses and Ferns. By Douglas Houghton Campbell, Ph.D., Professor of Botany in the Leland Stanford Junior University. Pp. vi + 544. (London: Macmillan and Co., 1895.)

BOTANISTS have been waiting with considerable expectation for the appearance of Prof. Campbell's book on the Archegoniate Series of Cryptogams. Neither the mosses nor the ferns and their allies have been comprehensively treated for some years, and thus, whilst much individual work has been accomplished in this department within recent times, it has become exceedingly difficult for those whose special interests happen to lie in other directions, to keep abreast of the ever-flowing tide of information respecting these most important families of plants.

Thus, had Dr. Campbell merely given us a text-book, in the sense in which that word is too often used—or misused—his claims to the gratitude of the morphologist might have been by no means inconsiderable. But in reality his treatise can scarcely be termed, with propriety, a text-book; and herein lies at once its strong and, we may venture also to add, its weak points. It is the outcome of a very extensive series of researches on the development and structure of the plants denoted as archegoniate cryptogams; and there is a peculiar freshness in the treatment, which can only be attained as the result of personal and intimate knowledge of the objects under discussion. This quality at once raises it far above the level of the ordinary book, in which the character of the compiler is often but too painfully apparent.

A very noticeable feature of the volume is the large space devoted to the consideration of the Liverworts. It is quite surprising how little attention botanists have been accustomed to pay to this group; many are quite content with acquiring a knowledge of *Marchantia*, which, as it happens, is a very specialised form, and not in the least degree typical of Liverworts taken as a whole. This neglect becomes the less intelligible when one considers the extreme diversity of outward form exhibited even within the limits of a single genus, a diversity only perhaps paralleled by some genera of lichens, or of algæ. And again, their position at the base of the archegoniate series should have sufficed to rescue them from a condition of such unmerited oblivion. Thus the author has done good service by devoting 140 pages to the Hepaticæ alone. It is, perhaps, to be regretted that he did not lay more emphasis on the extent of morphological specialisation which may be observed amongst the species of individual genera; thus, for example, all gradations may be traced in forms included in *Symphyogyna*, from a creeping flat thallus to a complicated branch system, recalling that of the sporophyte of many Hymenophyllaceæ. No doubt this would have entailed an increased number of pages, but, we think, the addition would have been very welcome.

We notice one or two slips here and there. Thus it is stated on page 97 that all the acrogynous Jungermanniaceæ possess a three-sided apical cell, whereas at least one species of *Physiotium* is known in which the cell is lenticular in transverse section. But these are but trivial errors, and the general summing-up of the Hepaticæ strikes us as extremely good, even though we may hesitate before accepting all the author's conclusions.

The Vascular Cryptogams are treated very fully, as one would have expected from a writer who has himself contributed so much to our knowledge of the group. But occasionally, if we may venture to say so, the investigator is perhaps a little too much to the front; and whilst individual plants are fully described, and very complete and minute accounts are given of the development of their various organs, one loses, to some extent, the feeling of a wide synthetic grasp of the plants as a whole. It is true, however, that this is atoned for by the suggestive summaries and discussions on phylogeny at the end of the chapters.

Many readers will probably wish that Prof. Campbell had devoted a little more space to a comparative treatment of the external forms, and had also given some account of the numerous biological adaptations which are so abundantly exhibited by many ferns and mosses; and we cannot help feeling that this would have been acceptable, even if it had necessitated the sacrifice of space now devoted to details of development.

The only point about the book which really strikes us unfavourably is the scanty recognition accorded to Palæontology. It is just amongst the vascular cryptogams that the palæophytologist is at his best, and we venture to express the hope that in future editions this most important branch of the subject may be far more fully treated.

If we have seemed to have indulged in a few adverse criticisms, this has not been done with any hostile intention, but merely by way of attempting to point out how, in our judgment, a really fine work may perhaps be improved. Enough, however, has, at any rate, been said to show that Prof. Campbell has rendered a most important contribution to the literature of botany; and we cannot, finally, suppress an expression of gratification that it should have appeared in the English language.

OUR BOOK SHELF.

A Laboratory Manual of Organic Chemistry. By Dr. Lassar-Cohn. Translated by Alexander Smith, B.Sc., Ph.D. Pp. vii + 403. (London: Macmillan and Co., 1895.)

IT will be readily understood in these days of rapid research that the appearance of a compendium of the latest reagents, processes and apparatus, intended to curtail the labour of the laboratory, would prove acceptable to organic chemists, and it is not surprising that the second German edition of this work should have appeared within a brief period. Its success in Germany may be taken as a guarantee that the English translation will be well received. The original will already have found its way, without doubt, into some of our laboratories. There are many useful laboratory methods scattered through the literature, which are frequently difficult to lay one's hand on at once. The present volume, which has been compiled with much discrimination, gives an account of all the important laboratory operations used in organic research, carefully described and illustrated. In these descriptions either the original account is reproduced, or a sufficiently detailed description is supplied by the author, so that a final appeal to the reference may generally be dispensed with—an important point, since herein lies the essence of the book's utility. The less important methods are briefly mentioned with a reference to the original paper. To try and strike a mean between these two extremes is obviously useless, and occasionally the author falls into this error. For example, under "aluminium chloride" (p. 105), it is stated that this substance is prepared from aluminium and chlorine. Then follows a fairly long account of a method by Gattermann, from aluminium and hydrochloric acid. The description is unaccompanied by any diagram, and is so incomplete that I am confident that any one who attempted to prepare it for the first time from this description would fail. In such a case the author would render a greater service by simply giving the reference.

The book does not aim at teaching the principles of organic chemistry, and it is perhaps not fair to find fault with some of the expressions and definitions used, which are apart from its main purpose. One brief reference may be permitted.

Chapter xii. (p. 10) contains a general account of "condensation." The writer has never met with any good definition of this term, and it is perhaps, as Gmelin said of the relation of organic to inorganic chemistry, more easily felt than defined; but surely we have here a needless confusion of ideas or, at least, of language. In the first paragraph we read: "By condensation we mean the formation of a substance from two others with loss of water, alcohol, hydrochloric acid, ammonia, or a halogen from both components." That the *two others* are not necessarily organic substances we learn from the next paragraph, where an example of condensation is given in the case of hydroxylamine and an aldehyde. Consequently we may include in this term the formation of ethereal salts, nitro-compounds, sulphonic acids, &c. Further down we read: "We include under this heading also the phenomenon of internal condensation, in which a body loses water and forms a new substance." Is the formation of ethylene from alcohol *condensation?* In the next para-

graph we are told that loss of water is not essential; but that polymerisation is a form of condensation. In the next we read: "By means of condensation (*i.e.* the formation of a substance from two others) chemists have been able to prepare far more new bodies and entire classes of bodies than by any other process."

With the exception of a few mistakes in spelling, especially of proper names, and a few omissions in the index, the work of the translator leaves nothing to be desired.

J. B. COHEN.

Physikalisch-chemische Propaedeutik, Erste Hälfte. Von H. Griesbach. (Leipzig: Wilhelm Engelmann, 1895.)

THIS work is designed mainly for the use of the chemist and the doctor; for, according to its author, the former, when engaged on certain legal inquiries or on questions relating to hygiene, must know something of medical science, and the latter, in order to follow his calling to advantage, must be familiar with much that is chemical and physical.

The present volume is the first half of the work, and deals with physico-chemical science and logic, the origin, nature, methods, and aim of physico-chemical science, measurement and systems of measurement, time, space, matter, energy, motion, velocity, the divisibility and constitution of matter, hypotheses regarding the ether, the atomic hypothesis, living and dead matter, organised matter as producing fermentation and disease, &c.

The reader requires no special scientific knowledge to follow the information supplied, which differs essentially from that given by most of the text-books, as a detailed historical account, containing short biographical sketches of leading investigators, is given in the case of each of the subjects dealt with. References are also given to original papers, and although the material discussed is mainly theoretical, apparatus and methods are also treated to some extent.

For a book which deals with subjects so widely apart as, say, the genesis of the elements and the karyokinesis of a living cell, the information is remarkably accurate, up to date, and well arranged; and the historical method adopted in the case of subjects which are but seldom handled in this way, makes the book specially interesting and valuable.

J. W. R.

The Pterophorina of Britain. By J. W. Tutt, F.E.S. Pp. 161. (Hartlepool: John E. Robson.)

ALTHOUGH dignified with the title of a monograph, this work, reprinted from the *British Naturalist*, is a carelessly compiled reproduction of almost every statement which has ever been published upon the British species of Plume-moths. Mr. Tutt has not attempted to condense into a useful or readable form this mass of crude material, which, however, may prove attractive to a certain type of collector. The generic diagnoses, unaccompanied by synoptic tables or figures, are taken mainly from Jordan's abstract of Wallengren's "Scandinaviens Fjädermott," and the specific characters are given mostly in the words of other writers, two or three descriptions being sometimes quoted for a single species. The book is roughly printed, and contains several misspellings of names; it will bring little credit to author or publisher, though as a compilation it may prove useful to those who care to search its pages.

Submarine Telegraphy and other papers. By James Bell, A.Inst.E.E., and S. Wilson. Pp. 63. (London: *Electricity* Office, 1895.)

A COLLECTION of papers, originally published in the columns of *Electricity*, dealing with matters belonging to technical telegraphy. Will be especially serviceable to persons engaged in the postal telegraph service, but appeals to all practical electricians.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Astronomical Theory of the Glacial Period.

TWO letters have recently appeared in NATURE (October 17, p. 594, and November 29, 1895, p. 29), in which Sir Henry Howorth attacks Sir Robert Ball as the author of a work entitled "The Ice Age," on the ground that the supposed astronomical cause of glaciation is totally inadequate to produce the alleged effect.

I do not now write because I have any new contribution to make to the discussion, but because the author of the review in NATURE (January 28, 1892) of "The Ice Age" might perhaps be expected to express an opinion on the subject in the columns of NATURE.

I still think that the book has the merit of laying down the simpler issue as to the direct effect of the variation in the eccentricity of the earth's orbit on climate, and of setting aside the many collateral causes with which Croll has somewhat clouded the subject.

I wish, however, to reiterate that Sir Robert Ball has, as I think, emphasised the wrong numbers, when he lays so much stress on the ratio 63 to 37, which expresses the ratio of the heat received by a whole hemisphere in its summer to that received in its winter. The really important point to consider is what change that ratio undergoes when the eccentricity of the orbit varies.

In my review it was shown that, with maximum eccentricity of the earth's orbit, and with summer in perihelion, the ratio of the daily supply of heat in summer to that in winter must be augmented by the factor $\frac{199}{166}$; whilst with summer in aphelion the same ratio must be reduced by the factor $\frac{166}{199}$. Thus the contrast between the two configurations is best represented by the ratio of 199^2 to 166^2, or of nearly 6^2 to 5^2, or say as 3 to 2. These are the numbers which deserve emphasis.

The astronomical theory has, however, been recently subjected to a powerful criticism by Mr. Culverwell in some papers in the *Geological* and *Philosophical Magazines*,[1] and the criticism is, I understand, adopted by Sir Henry Howorth. A concrete case (using only round numbers) will express very shortly Mr. Culverwell's argument. At present, with practically zero eccentricity of the earth's orbit, in latitude 51° the ratio of the daily supply of heat in summer to that in winter has a certain magnitude, say A. Then the corresponding ratio for latitude 55° is $\frac{5}{6}$ A; and for latitude 47° is $\frac{6}{5}$ A. Now this difference is found to have nearly the same value, viz. 4°, for all the middle latitudes, so that it may be concluded that the alleged cause for glaciation would give London a climate something like that of Yorkshire; and the converse would produce a climate something like that of mid-France. The parallelism of the two cases is by no means perfect; but with allowance of the widest margin of uncertainty, it seems that neither a polar nor a tropical climate could be produced by the astronomical cause.

Is there any great flaw in Mr. Culverwell's argument? I do not at present see one; and great as are the uncertainties of the case, they seem insignificant as compared with those involved in calculations founded on the temperature of space, as used by Croll and Ball. Mr. Culverwell has independently carried to its logical conclusion the same line of argument as that of my review, and I can now only confess with regret that I did not perceive whither it tended.

The astronomical theory of the great changes of climate of which geology affords evidence is so alluring, that I cannot sur-

1 *Phil. Mag.*, December 1894, p. 541; *Geolog. Mag.*, decade iv. vol. ii. No. 367, p. 3, January 1895, and No. 368, p. 55, February 1895. Since this letter has been in type, I have read a valuable paper by Mr. G. F. Becker (*Amer. Journ. Sci.*, vol. xlviii. August 1894), in which he concludes that zero eccentricity of the earth's orbit will present the condition most favourable to glaciation. I have to thank Sir H. Howorth for reminding me of this paper.

render it without regret, and should gladly welcome a destructive criticism of Mr. Culverwell's argument.

I have had some conversation with Sir Robert Ball on this subject, and I find that he is not as yet disposed to change his opinion. He contends that, when we bear in mind that it is in the tropics that the great oceanic currents get their warmth, we should admit that the change in the daily supply of heat by one-fifth part is competent to produce a great change in northern climates. Whilst I think that he would not now lay much stress on the quantitative results derived from the supposed temperature of space, he would still maintain that the cause is adequate to the effect. But does not this bring us nearly back to Croll's point of view, and demand a discussion of the effect of diminished or increased sun-heat on oceanic circulation?

December 16, 1895. G. H. DARWIN.

[At the request of the Editor, one sentence has been erased from the original letter.]

Barisal Guns.

WITH reference to Prof. Darwin's letter in NATURE of October 31, 1895, relative to Barisal Guns, I enclose a communication, which I received from an observer familiar with the phenomenon.

Medical College, Lahore. D. G. F. GRANT.

I first heard the Barisal Guns in December 1871, on my way to Assam from Calcutta through the Sunderbans. The weather was clear and calm, no sign of any storms. All day the noises on board the steamer prevented other sounds from being heard; but when all was silent at night, and we were moored in one or other of the narrow channels in the neighbourhood of Barisal, Morelgunge and upwards, far from any villages or other habitations, with miles and miles of long grass jungle on every side, the only sounds the lap of the water or the splash of earth, falling into the water along the banks, then at intervals, irregularly, would be heard the dull muffled boom as of distant cannon. Sometimes a single report, at others two, three, or more in succession; never near, always distant, but not always equally distant. Sometimes the reports would resemble cannon from two rather widely separated opposing forces, at others from different directions but apparently always from the southward, that is seaward. We were not very far from the sea when I first heard them, and on mentioning to an old lady on board that I heard distant cannon, she first told me of the mysterious sounds known as the "Barisal Guns." For the next two years I was in Upper Assam, above Goalpara, and do not remember ever hearing them there; but in 1874 I was working in the Goalpara district in the tract south of Dhubri, between the Brahmaputra and the Garo Hills; sometimes near the river, sometimes near the foot of the hills, at others between the two. I gradually worked down as far as Chilmari Ghât (I think it is called), the landing-place for Tura, the headquarters of the Garo Hills district, and distant quite 300 miles from the mouths of the Brahmaputra and Ganges. The villages are few and far between and very small, firearms were scarce, and certainly there were no cannon in the neighbourhood, and fireworks were not known to the people. I think I am right in saying I heard the reports every night while south of Dhubri, and often during the day. The weather on the whole was fine. Short, sharp "nor'westers" occasionally burst on us of an evening, with much thunder and lightning; but the days were clear, and, as a rule, the sounds were heard more distinctly on clear days and nights.

I specially remember spending a quiet Sunday, in the month of May, with a friend at Chilmari, near the river-bank. We had both remarked the reports the night before and when near the hills previously. About 10 a.m. in the day, weather clear and calm, we were walking quietly up and down near the river-bank, discussing the sounds, when we heard the booming distinctly, about as loud as heavy cannon would sound on a quiet day about ten miles off, down the river. Shortly after we heard a heavy boom very much nearer, still south. Suddenly we heard two quick successive reports, more like horse-pistol or musket (not rifle) shots close by. I thought they sounded in the air about 150 yards due west of us over the water. My friend thought they sounded north of us. We ran to the bank, and asked our boatmen, moored below, if they heard them, and if so in what direction. They pointed south!

As we often did with boatmen, we asked these their opinion of the sounds. They said they heard them at all seasons and in every direction all up the river from Serajgunge to Dhubri—their beat; that they were in the air, and came from the gods (Deota) celebrating the continuous marriage of the Ganges (the goddess Ganga) with the Brahmaputra (son of Brahma); that they were heard in their fathers' time, and long before. We could elicit nothing further from them or others.

The year previous I had discussed the sounds with Captain Stewart, of the Survey of India Department, who had some years previously been employed on the Survey of the Sunderbans tracts. He said the reports were heard all over the Sunderbans; that several experts had failed to account for them. He once had a theory that they were caused by submarine eruptions in the Bay of Bengal; but this would hardly account for them 300 miles distant, and I believe they are never heard out at sea in the bay.

I have heard planters (who have heard them near the hills where bamboo jungles abound) say that they were merely reports caused by bamboos bursting in jungle fires. But they are heard far from all bamboo jungles, and in the absence of jungle fires.

Strange to say, I next heard the reports when crossing the Mahanadi River, between Purnea and Kishengunge in the old road from Sahebgunge to Darjeeling.

The time was about ten at night, the evening close, hot, and very cloudy, but no thunder anywhere. The booming sounded some miles away. There are no cannon anywhere in the neighbourhood, nor any large cities where possibly fireworks might be in progress. The year after I heard them again at the same place; on this occasion the sky was clear and starry, the time between 3 and 4 a.m., the booming distant but very distinct.

I have no theory. I fancy the sounds must be purely electric, but certainly have nothing to do with clouds, nor with cannon, nor fireworks, nor jungle fires.

If I can answer any other questions on the subject, I will be pleased to do so; but I think I have told you all I know.

G. B. SCOTT.

Remarkable Sounds.

I HAVE this day received from the Rev. W. S. Smith, Congational Minister of Antrim, Ireland, the following account of natural sounds connected in some way with Lough Neagh. The details are so interesting that I send them as a contribution to your present correspondence on natural sounds.

Highgate, N., December 19, 1895. C. TOMLINSON.

Lough Neagh is a sheet of water covering an area of upwards of 150 square miles, with very gradually receding shores, excepting at one or two spots. For many years after my settlement as minister here from England, I heard at intervals, when near the lake, cannon-like sounds; but not being acquainted with the geography of the distant shores, or the location of towns, or possible employments carried on, I passively concluded that the reports proceeded from quarrying operations, or, on fine summer days, from festive gatherings in Co. Derry, or Co. Tyrone. In time I came to understand that it was not from the opposite shores, but from the lake itself that the sounds proceeded. After questioning many of the local residents, I extended my inquiries to the fishermen, but they could assign no cause. A strange thing about the matter is that the people generally knew nothing of the phenomenon, and that it is shrouded in mystery. I have heard the sounds during the whole year. . . . I have heard the reports probably twenty times during the present year, the last being on a Sunday afternoon a month since, when I heard two explosions; but with two exceptions they have all seemed to come from many miles away, from different directions at different times. They have come apparently from Toome Bay, from the middle of the lake, and from Langford Lodge Point, about nine miles distant. A fisherman thought they must be the result of confined air that reached the lake by means of springs that are believed to rise here and there in the bottom. But the lake is shallow, seldom more than 45 feet deep. The depression now covered by the lake having been caused, it is believed, by volcanic action when the trap-rock of Co. Antrim was erupted, there may possibly be subterranean passages, though I confess their occurrence does not seem very probable; while the sounds emanate, as stated, from various parts of the lake. I have as yet spoken to no one who observed any movement of the waters when explosions took place, nor have I spoken to any one who was close to the spot at the time. Rather every one seems to have heard them only in the distance, which is strange, as fishermen are on the lake during many months in the year, at all hours of the day and night.

Last winter the whole of the lake was frozen over, for the first time since 1814. One fine afternoon, when the air was still, I was skating in the neighbourhood of Shande's Castle, when these mystical guns boomed forth their reports every five or six minutes. On the last day of the skating, when thousands of people from Belfast and elsewhere were assembled in Antrim Bay, there were two fearful boomings, that startled every one near me. They seemed to think some dreadful catastrophe had occurred, as the sounds appeared to proceed from not more than half a mile away. I never before heard them so near. The ice in Antrim Bay remained as it was, but I afterwards learned that it was then breaking up six miles away, but with no alarming sounds. Last February, when the ice of Lough Neagh was breaking up, a strange occurrence took place at Ardmore. A great ridge of ice, a mile and a half long, and 10 feet high, and 15 feet at the base, was formed along the shore during three days. There was a dead calm at the time, so that the ice was not thrown up by the waves. The ice along this part of the shore, for a third of a mile out, was intact; the ridge must have consisted of ice brought from a considerable distance, and forced under the shore ice, which was raised every few yards into small archways, and then shot out from beneath to the height previously specified. The pieces of ice were from half a yard square to bits of an ounce in weight, all mingled in the huge mass. Such a sight had not occurred since 1814, when, as I learned from a member of my congregation, who had seen it in that year, the water of the lake could not be seen from the shore-road on account of this icy obstacle. There are currents in Lough Neagh, but I am not aware of any strong enough to produce such an effect. W. S. SMITH.

Postcript.—In my former letter, an extract was given from Major Head's work, published some fifty years ago, and on again referring to it, I find the following passage:—"The cold increased to a very low temperature, the effect of which upon the extended sheet of ice that covered the bay, was remarkable. It cracked and split from one end to the other with a noise that might have been mistaken for distant artillery." This explains the sound to some extent in winter, but Mr. Smith says that the cannon-like sounds may be heard at any time of the year. This requires explanation. C. T.

IN your issue of November 14 last, Prof. McKenny Hughes appears to favour the idea that the curious sounds heard near the shores of Morecambe Bay, are due to the waves breaking "on the long, flat shore" thereof. I heard these sounds on Saturday, December 21, and could trace them to blasting operations near Carnforth. I heard them between 9.15 and 9.30 a.m., and the *tide was quite out*. So the "very suggestive coincidence" between the Bays of Bengal and Morecambe loses point! Further, it is seldom that the waves break at all, or even "curl over" on the shores of Morecambe Bay, where it is flat; but the water simply overflows the banks of the channel of the river Kent, whose course is followed by the tidal wave. There are limestone quarries at or near Arnside, Silverdale, Warton, Carnforth and Borwick. O. FIRTH.

Hawthorn House, Baildon, Yorks.

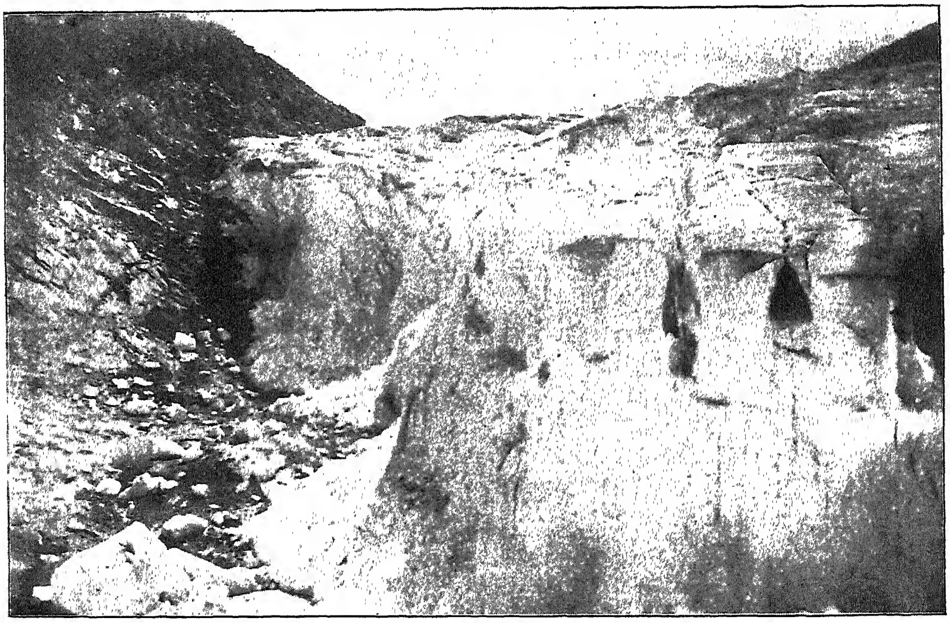
CHARLES DARWIN, in his "Naturalist's Voyage round the World" (new edition, 1890, p. 346), describes some curious earth-sounds heard in Northern Chile; he also gives references to Seetzen and Ehrenberg as authorities for the occurrence of similar sounds on Mount Sinai, near the Red Sea.

It is stated that the phenomenon is caused by sand in motion. WILLIAM STONEY.

Civil Service Club, Capetown, December 4, 1895.

The Merjelen Lake.

THE annexed illustration is reproduced from a photograph taken by me on August 16, 1890, when the lake was empty. How long it had been so, or how long it continued, I cannot say. So far as my memory serves me, there was no water whatever in it, and I distinctly recollect noticing the icebergs lying



high and dry on the bottom. I walked along what had been the margin of the lake on my way to the Aletsch glacier, which I ascended to the Concordia Hut. I hope the photograph may be of interest to Dr. Preller, and others who know the lake. GREENWOOD PIM.

Co. Dublin, December 19, 1895.

The Metric System.

I NOTE a call from Mr. John W. Evans, in NATURE for December 5, 1895, for the use of the metric system in meteorology. If this means the substitution of the metre for the yard, there can be no serious objection except this. In meteorological studies ·01" of air pressure is an extremely convenient limit, and in most inquiries only two figures are needed. On the other hand a millimetre (·04 inch) is altogether too large a limit, and one-tenth m.m. is too small. The labour of writing, averaging, and studying with the metric scale will be at least one-third greater than with the common inch scale to the same degree of accuracy. It is a very great pity that the French, in looking

for a convenient length to divide into a thousand parts, did not take up the already existing yard, which is nearly the same as the metre. Yard ÷ 1000 = (metre ÷ 1000) - ·004 inch. The amount of confusion that would have been saved is almost incalculable.

The metric system usually carries with it the Centigrade scale on the thermometer, and here the whole English-speaking world should give no uncertain sound. I am not contending for any scale in chemistry or geology, but in meteorology it would be difficult to find a worse scale than the Centigrade. The plea that we must have just 100° between the freezing and boiling points does not hold; any convenient number of degrees would do. The Centigrade degree (1°·8 F.) is just twice too large for ordinary studies. The worst difficulty, however, is in the use of the Centigrade scale below freezing. Any one who has had to study figures, half of which have minus signs before them, knows the amount of labour involved. To average a column of thirty figures, half of which are minus, takes nearly double time that figures all on one side would take, and the liability to error is more than twice as great. I have found scores of errors in foreign publications where the Centigrade scale was employed, all due to this most inconvenient minus sign. If any one ever gets a "bee in his bonnet" on this subject, and desires to make the change on general principles, it is very much to be hoped that he will write down a column of thirty figures half below 32° F., then convert them to the Centigrade scale, and try to average them. I am sure no English meteorologist who has ever used the Centigrade scale, will ever desire to touch it. It is much easier and safer to convert the Centigrade scale to the Fahrenheit before any studies are made. As a matter of fact, European temperatures are a sealed book to active workers in meteorology on account of this unfortunate scale.

England and the United States may congratulate themselves, however, in the fact that European meteorology is almost flat. There are no low area or high area systems moving with regularity at any definite speed or in any definite direction, such as are experienced in the United States three or four times in a month. The rains in Europe are mostly sporadic, and do not accompany any well-defined low areas.

If any change is to be made, cannot the meteorological world come together upon a thermometer having its zero at -40° both Fahrenheit and Centigrade. This would be a most convenient scale, and would eliminate nearly all minus signs. The conversions from the old to the new would be very convenient by simply adding 40° to each. The conversion from the new Fahrenheit to the new Centigrade would also be extremely convenient by dividing by 1·8 instead of the present very puzzling system, and *vice versa*, Centigrade degrees + 1·8 would give the Fahrenheit value. This would obviate the difficulty of the minus sign, but there would still remain the fact that the Fahrenheit degree is by far better than the Centigrade.

Washington, D.C., December 18, 1895. H. A. HAZEN.

Apparatus for determining the Specific Gravity of Minute Fragments of Minerals.

THIS is a contrivance designed to facilitate the measurement of the specific gravities of minute fragments of minerals by means of a diffusion column of methylene iodide, as described by Prof. Sollas in NATURE, vol. xliii. p. 404, and vol. xlix. p. 211. There is no new principle involved in the construction of the instrument. It is merely the adaptation to this particular purpose of a well-known device for getting rid of the error due to parallax, such as is employed in Prof. Joly's spring balance for determining specific gravities, and the best form of tangent galvanometer. The index, which in this case is a fine wire, or fibre of any kind, is reflected in a mirror placed behind it, the coincidence of the fibre and its reflection showing that the eye of the observer is exactly on a level with the index.

In the drawing, *a* (Fig. 1) is a test tube containing the methylene iodide column in which the fragments of mineral under observation are immersed, together with two or more beads or fragments of mineral whose specific gravity is known. This is held by a clip, *b*, in a slot cut through the upper end of a thin piece of wood, some 12 inches high, fixed vertically to a firm base, so as to bring the test tube and its contents to a convenient height above the table. A slip of mirror, *d*, carrying a scale, *e*, divided in millimetres or any even graduations, is fixed vertically at the side of the slot, and the fibre is carried by a slider, *c*, which is shown separately in Fig. 2. This may be made of a strip of thin sheet copper, and has a "window" cut through it at *b*, so that the contents of the test tube may be seen.

The readings are taken by bringing the fibre successively on a level with the approximate centre of gravity of each fragment,

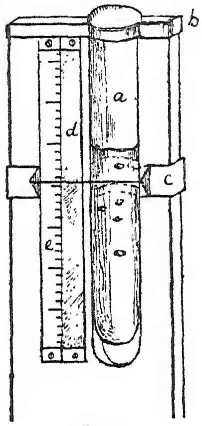


FIG. 1.

and noting the division of the scale cut by it, taking care that it coincides with its reflection in the mirror at each reading. The instrument might be improved by making the scale movable through a short distance vertically, so that one of the larger divisions of the scale might always be brought on a level with

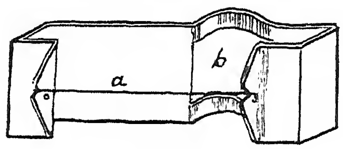


FIG. 2.

the uppermost of the beads or fragments used as indicators. The whole thing may be made at a cost of less than a shilling. It has been tried in the geological laboratory of the Royal College of Science for Ireland with satisfactory results.

T. D. LA TOUCHE.

Cactaceæ in the Galapagos Islands.

MR. HEMSLEY is mistaken in stating, as he does on p. 623 of NATURE for October 24, 1895, that Dr. G. Baur was attached to the U.S. Fish Commission Steamer *Albatross*. Dr. Baur had no connection with the *Albatross* Expedition of 1891, the object of which was deep-sea dredging, and only included an incidental visit of a few days to the Galapagos. Nor did Dr. Baur write the general sketch of that expedition, or have anything to do with the photographs which accompany it, as one might infer from a subsequent note by Mr. Hemsley on the Cactaceæ of the Galapagos (NATURE, November 14, 1895, p. 31).

As regards the Cactaceæ of those islands, I collected branches of *Opuntia* and of *Cereus* from Chatham and from Charles Islands; what became of those pieces I do not know, as they do not seem to have reached the hands of Dr. J. N. Rose, who described the plants collected at the Galapagos by the *Albatross* Expedition.

Mr. Hemsley will find that both Dr. Wolf and myself state that *Cereus* grows to 20 feet in height. Dr. Wolf also called attention to some striking differences he had noticed in the specimens of *Opuntia* and of *Cereus* he found on the different islands.

In stating his position, botanically speaking, regarding Dr. Baur's theory of the origin of the Galapagos, Mr. Hemsley would surely not give us to understand that *Opuntia* and *Cereus* are limited to Chili on the west coast of South America, as his second note (p. 31) seems to imply. ALEXANDER AGASSIZ.

Museum of Comparative Zoology, Cambridge, Mass., December 2, 1895.

[MR. HEMSLEY admitted, in NATURE of November 28, 1895, that he was in error in thinking Dr. Baur was attached to the U.S. Fish Commission Steamer *Albatross*.—ED. NATURE.]

THE VENEZUELA AND BRITISH GUIANA BOUNDARY.

THE sudden accession of an acute phase in the question of the boundary-line between British Guiana and Venezuela, has attracted the attention of the whole world to a controversy which has been proceeding intermittently for nearly a century. With its political aspect the pages of NATURE have no concern; but from another point of view it affords an opportunity for enforcing some of those scientific principles of geography, the ignorance or neglect of which has done much to embarrass the relations between neighbouring countries.

The fundamental error is to suppose that any piece of land on the face of the globe is so worthless that its ownership once claimed may be left undefined. So long as forest or plantation products alone, or mining alone, or any other partial potentiality of land is considered by itself, it is perfectly natural for colonists and governments to postpone expensive surveys of tracts that promise no immediate advantages, or to delay troublesome negotiations. In the end more trouble and more expense have to be faced, often in unexpected quarters.

Political geography is no longer a matter to be treated tentatively by politicians, any more than industrial chemistry is now a matter for the uninstructed experiments of tradesmen. It is the highest outcome of geographical theory, a theory which deals without a break with all terrestrial distributions, from the primary elements of geomorphology and climatology, to the adjustment of life to environment in the progressively more complex cases of plant, animal, and man. So little attention has been paid in this country to geography as a science with a definite purpose, and so few explorers have been equipped with even an elementary acquaintance with the principles of geography, that we gladly seize this opportunity to urge the importance of geographical theory as a guide to the prevision and prevention of frontier-disputes.

Two stages are necessary in arranging a frontier—drawing it on a map, and demarcating it on the ground. For the former purpose it is easiest to take a mathematical line, a meridian or parallel; for the latter some distinct physical feature, and of these there are only two which can be looked on as satisfactory—a watershed or a *Thalweg*. In practice the *Thalweg*, which is the line along which converging slopes meet, as the watershed is the line along which diverging slopes meet, means the central line of a river. The sea counts as neutral territory in all international affairs, and the coast-line requires no definition. The position of a parallel may be determined astronomically with great exactness, and, when marked on the ground by posts within sight of each other, is perfectly explicit; but it involves highly-skilled work and the agreement of two parties of expert surveyors. The case of a meridian may also be settled, but can rarely be free from the risk of rectifications being demanded, as more exact methods of determining longitude become available. Noteworthy exchanges of territory may thus be necessitated, perhaps involving hardships to individuals. A great mountain seems a peculiarly fitting corner-stone for the meeting of national frontiers, and is so used in the case of Mount Ararat; but Mount St. Elias has had to change its nationality by the rectification of the meridian of 141° W. Such a boundary-line as that between the southern part of Alaska and British Columbia, a line parallel to the coast, and ten leagues distant from it, represents perhaps the least scientific frontier on the face of the earth. It might be possible, when large scale maps are made of the fjord-riven coast, to draw this line on them; but only mutual goodwill and concessions could ever have allowed it to be even approximately marked on the ground.

In the particular instance before us, a map published by the Venezuelan Government in 1890, which it is impossible to reproduce on a small scale without the use of colour, shows the ten hypothetical western boundaries of British Guiana which have been put forward by one side or the other in the course of negotiations. Most of these lines are an outrage on geography, and it is difficult to believe that some of them were seriously put forward by the statesmen whose names they bear. We have been unable to find any British map showing these proposed boundaries, and it does not appear that our Foreign Office has published one. The boundaries in many cases cut natural features and mathematical lines at all angles and in irregular curves which it would be impossible either to describe verbally or to lay out accurately on the ground without a survey as minute as for a railway. These we do not require to dwell on, except in the way of pointing the moral that the results of geography should be officially recognised by Government departments more fully than has hitherto been the case. The Intelligence Division of the War Office is, in a sense, the Government Geographical Department, but it is concerned mainly with the practical work for the Army, and might well be supplemented by a more purely geographical office. It is true that the Royal Geographical Society is always ready to render help when called upon, and does not infrequently answer questions as to matters of fact. What is wanted, however, is rather an official geographer who may be consulted by the Government on matters of geographical theory as well as of fact, and who might be charged with the duty of preparing and keeping up to date an official geography of the British Empire.

The geographical conditions of the present boundary difficulty can be stated easily, so far as the main features are concerned; but the details are many and complicated. A boundary dispute in itself is a quite normal condition in South America. The boundaries of every republic in that continent are disputed; in several cases three neighbouring countries claim the same territory. It is impossible to draw a political map of South America, even on the smallest scale, that would be generally acceptable. In the case of Guiana, it is well to look at the physical condition of the land before tracing the contested boundaries. From the mouth of the Orinoko to the mouth of the Amazon the coast of South America runs nearly south-east, and the distance is 1000 miles. A line drawn from river to river, about 500 miles inland from the coast and parallel with the coast-line, contains the whole region known as Guiana. It consists of a gently rising plateau of Archæan rocks edged by very low plains of quaternary formation, bordering the Orinoko on the north, the Atlantic on the north-east, the Amazon on the south, and forming the llanos of the Rio Negro and Upper Orinoko on the south-west. The plateau bears a number of low mountain ranges, which have been made familiar by recent explorations; the Tumak-humak, Akarai, Pacaraima (including Roraima), Parime and Imataka, amongst others. The trade winds bring a heavy and regular rainfall to the whole eastern slope, causing it to be clothed with perhaps the richest and densest tropical forests of the world. On the top of the plateau, and on the western slopes, there is a reduced rainfall, and in accordance with this savannahs take the place of woods. Many large rivers carry off the surplus rainfall; of these we may name, on the north-eastern slope, from south to north, the Araguary, Oyapok, Maroni, Korentin, Essequibo (including the Mazaruni and Kuyuni), and, turning north-westward towards the sea, the Barama (or Guiana), Barima, and Amakuru. Every one of these rivers flows through dense primeval forests for the greater part of its course, and discharges on a muddy coast-line, which is rapidly growing seawards, thanks to the aid of mangroves.

On the south-western slopes the rivers are much longer,

and flow to the Amazon and the Orinoko, the two great river-systems being connected, as is well known, by the natural canal of the Casiquiare. The more westerly rivers flow, for the most part, through open savannah country; so that the water-shed of the plateau is much more accessible from the Orinoko on the west and north than it is from the Atlantic on the north and east. From Mount Roraima south-eastward *Thalwegs* of the upper tributaries of the Rio Branca form a political boundary to near the source of the Essequibo, after which the water-shed is a political boundary, the whole southern slope (except a small portion of the Rio Branco basin included in British Guiana) constituting Brazilian Guiana. From Roraima westward the whole area draining to the Orinoko River incontestably belongs to Venezuela. The present frontier disputes concern the forest-covered Atlantic drainage area, which is shared by the only three colonies remaining in South America—British Guiana on the west, Dutch Guiana in the centre, and French Guiana to the east. Here most of the boundaries are *Thalwegs*, *i.e.* the central line of rivers. There is no question as to Dutch Guiana, which is demarcated by treaty from British Guiana by the Korentin, and from French Guiana by the Maroni. But here certainty ends. The French and Dutch differ as to which of the upper tributaries of the Maroni should be taken as the boundary between Dutch and French territory. The Brazilian Government recognises the Oyapok as the French boundary toward Brazil; the French claim the Araguary, the space between the two rivers which flow nearly at right angles to each other being a triangle with 250 miles of coast as a base. The uncertainty of boundaries at the east of Guiana is simpler to understand, and easier to explain than that at the west. The claim of Venezuela is that British Guiana is bounded by the *Thalweg* of the Essequibo, and it is so represented on Venezuelan maps. The extreme British claim, on the other hand, is that the whole drainage area of the Essequibo belongs to the colony, *i.e.* that the boundary is the main watershed of the plateau as far as the Imataka range on the north, which runs parallel to and very near the Orinoko. In addition, there is a claim for the basins of the small rivers which occupy the triangular area between the drainage areas of the Orinoko and the Essequibo. If the western boundary of British Guiana were to be of the same type as those of the other colonies, it would require to be the *Thalweg* of a river flowing into the Atlantic, *i.e.* either the Essequibo, the Mazaruni, the Kuyuni (these three unite to enter the sea at a common mouth), or the Barama (Guiana), Barima, or Amakura.

It is now too late to suggest the solution of the boundary problem by geographical principles. Were it not so, a very interesting argument could be held as to how far the physical unity of a drainage basin is impaired by the obstacles to movement along the *Thalweg* due to cataracts interrupting navigation on the rivers, and forests obstructing progress on land. It is, in fact, very much easier to reach the upper basin of the Kuyuni branch of the Essequibo over the savannahs from the Orinoko than through the forests from the Atlantic coast.

All modern maps of Guiana—except the Venezuelan—follow what is known as Schomburgk's boundary, either in its original or in a modified form.

In 1840 the Schomburgk line first appeared on a sketch map, the topography of which was very inexact. From the Amakuru River in the north it ran along the watershed southwards, thus leaving the whole basin of the Barima in British Guiana. It so happened that the line ran nearly on the meridian of 60° W. as far as the Kuyuni River; and when the Barima was found to rise far to the west of that meridian, the line was often still drawn along it, instead of following the watershed as was intended. In 1886 the British Government modified the line by carrying it along the Kuyuni River to its source, and then for a short distance along the watershed, to Roraima.

The whole area within the Schomburgk line has been taken into effective possession by the Government of British Guiana so far as a tropical forest of such magnitude can be occupied. The Barima River was recently explored to its source by Mr. G. G. Dixon, and the account of his journey in the *Geographical Journal*, for April 1895, gives some idea of the difficulty of forcing a way through the woods. Much of the land is auriferous, and the real point of the present frontier difficulty lies in the value of Yuruari mines in the upper basin of the Kuyuni, at present occupied politically by Venezuela, and commercially by the nondescript cosmopolitan population always attracted to gold-fields.

It is this fact that makes it hopeless to expect the dispute to be settled by the geographical principles which forty years ago could have easily prevented it. The only alternatives are to base the rival claims on actual effective possession, or on the original rights which were recognised between the Dutch settlers in Guiana and the Spanish colonists of the Orinoko at a time when the geography of the district was practically unknown. The romantic story of British enterprise in Guiana is admirably told in Lucas' "Historical Geography of the British Colonies," vol. ii., a work of admirable clearness and brevity.

D'Anville's atlas of 1772 shows practically the whole of the disputed area as Dutch Guiana, but contemporary and later maps are very conflicting, and all of them being unofficial are of small value as evidence. The chart of Captain Edward Thompson, who took part in the first capture of the "Wild Coast" from the Dutch in 1781, marks the Barima as "the western boundary of the Dutch according to their claim," but does not suggest any boundary in the interior. The rights and wrongs of historic evidence will doubtless be fully investigated by those responsible for a decision, and the present dispute will probably be settled, as similar difficulties have been settled before, by some judicious compromise which will give both parties the inestimable benefit of a fixed and definite frontier. But similar disputes will continue to arise in other places, and their solution will be protracted and rendered difficult as long as unsurveyed territory is claimed by rival powers, spurred on by rival concessionaires and interested company promoters.

The recent International Geographical Congress decided that the time had come when all governments should be urged to make a map of their possessions on the uniform scale of 1 : 1,000,000, or about sixteen miles to an inch. If the governments of all countries were jointly to take this matter up, survey all unsurveyed lands which they claim, and submit the uncertain boundaries, which are not yet complicated by gold-mines, to an International Commission of Geographers, to be decided on the basis of the new map on purely geographical principles, the expense would be many times saved by the security which defined frontiers give, and a magnificent contribution to science would be effected.

HUGH ROBERT MILL.

DR. JOHN RUSSELL HIND, F.R.S.

It is with deep regret that we announce the death of Dr. J. R. Hind, whose name and whose work were possibly more familiar to astronomical students of the last generation than they are to those of to-day. By this we do not mean to imply that Dr. Hind had outlived his reputation, but that circumstances forced him to the front early in life and in connection with subjects that have long since ceased to attract or to interest. His claim to scientific reputation and remembrance will

mainly rest on his long connection with the *Nautical Almanac*, and the steady character for accuracy and efficiency that it maintained under his direction. But to the production of the *National Ephemeris*, while one is responsible, many contribute, and no one would admit more readily than the late chief of that department, how much he was indebted to the invaluable aid he received from such assistants as Messrs. Richard Farley, Godward, and others, or more willingly share the credit with those less well-known authorities. For these and other reasons, it is not a little difficult to assign to Dr. Hind his proper place among astronomers. He never devoted himself in any way to the higher branches of physical astronomy; the mathematical training that is sufficient for an engineer is not of that character that is required to advance our knowledge of planetary theories, or to assist their development by new functions. He will rank rather with the school of Argelander, to whom he was deeply attached, than with that of Bessel or Le Verrier. It is equally true that he never had occasion to employ the newer methods of observation that spectroscopy and photography demand, or to discuss the results obtained by their means, since the habits of his life and the direction of his work were settled before these methods of investigation were generally employed. Looked at, therefore, from the broader ground that astronomy now occupies, his scientific life seems somewhat cramped; but to conclude that his career was misspent, would be to read the history of astronomy for the last half-century very incorrectly. He was emphatically a practical astronomer, and whether as an observer or in making the mathematical work of others available for practical ends, he had few equals. He knew his capacity very well; he attempted nothing beyond his powers, and few men have made fewer mistakes.

As already intimated, Dr. Hind was originally intended for the profession of engineering, a science for which he had little taste, and it was fortunate for his subsequent career that circumstances permitted him to join the staff of the Royal Observatory. He was attached to the magnetical and meteorological department, at that time not fully organised nor even confidently regarded as a permanent part of the establishment. In those early days (1840), self-recording instruments were practically unknown, and meteorological readings and general attention to details required all-night sittings from the assistants. It was in these long watches that he acquired the habit of calculating comet and planetary orbits, undertaken at first with the view to keep himself awake, but which grew into a confirmed habit, and laid the foundation of his reputation as a computer. In 1844 he left Greenwich to take charge of Mr. Bishop's private observatory at Regent's Park. At that time Neptune was not discovered, and the first work that he began at that observatory was the formation of ecliptical charts of stars, three degrees each side of the ecliptic, with the view of detecting the object that disturbed the motion of Uranus. The comparison of these charts with the heavens led to the discovery of a number of small planets, which then were objects of interest and importance. Some variable stars, and a few comets of which he was the fortunate discoverer, extended his reputation and attested his zeal as an observer. Meanwhile the habits of calculation that he had acquired at Greenwich, were never allowed to lay dormant, and every *Nachrichten* as it came to England contained the orbit of a comet or a new planet which he had contributed to its columns. The history of ancient comets, the unravelling of the tedious descriptions of old or of Chinese astronomers, was his constant occupation, so that he acquired a masterly knowledge of the history of that portion of astronomy, and at one time we believe he had the intention of publishing an annotated *Pingré*. That such a work would have enhanced his reputation, and shown him to be the possessor of much curious information gleaned from many authorities, cannot be doubted, but the pleasure he derived from clearing up doubtful points, and adding to his own stock of information, were his only reward.

His facility as a computer led to his selection for the post of Superintendent of the *Nautical Almanac* when a vacancy occurred in 1853, through the death of Lieut. Stratford, and it will generally be admitted that he filled the post with credit to himself, and to the extended reputation of the important work of which he had charge. Official duties to some extent interfered with his private researches, but his industry was always very great. The list of papers to which Dr. Hind's name is attached in the Royal Society's "Index," though considerable, does not exhibit the full measure of his computational activity, because he did not often publish his results. An examination of this "Index" will, however, show the large variety of astronomical topics to which he turned his attention. And to this list we can only refer, without mentioning any particulars. But, in this place it would be ungrateful not to recall the fact that the deceased astronomer was the first contributor to our "Astronomical Column," and for some years the whole of the "Notices" were written by him. Neither can we undertake to give a complete list of the honours and awards that were showered upon him. He received the medals of both the Royal and the Royal Astronomical Society, the Danish Medal for cometary discovery, and the Lalande Medal on more than one occasion. He was made a Corresponding Member of the Institute of France, and many other foreign societies placed his name among their honoured members. The writer of this brief notice trusts that it may not be out of place for him to record his own sense of indebtedness for many acts of kindness and much valuable information that he has received at the hands of Dr. Hind. WILLIAM E. PLUMMER.

NOTES.

THE list of New Year Honours includes the names of two well-known men of science—Sir Joseph Fayrer, K.C.S.I., who has been made a baronet, and Prof. Prestwich, who has been knighted. If long and distinguished services to the cause of science count for anything, both Sir Joseph Fayrer and Prof. Prestwich have well earned the honours conferred upon them. Mr. H. H. Johnston, C.B., has been promoted to the Knighthood of the Bath; but this is probably more on account of his administrative work in recent years than for his explorations in Africa.

THE late Baron Larrey has left a bequest to the Paris Academy of Sciences for an annual prize of 1000 francs for the best treatise by an army doctor on any question of medicine, surgery, or sanitation.

PROF. A. ARCIMIS, writing from Madrid, informs us that at 6 p.m. on December 25, 1895, an earthquake was felt in some villages of the province of Orenne, Galicia, north-west of Spain. Some walls were cracked, the clocks stopped, and two small houses were thrown down.

THE commercial prospects of Hudson Bay are receiving much attention. Notice has been filed of application to the Canadian Parliament for a charter to construct a railroad from Calgary, on the Canadian Pacific Railroad, to Fort Churchill.

THE inhabitants of Zürich have rejected, by 39,476 votes to 17,297, a proposal submitted to them for the absolute prohibition of vivisection. On the other hand, a counter proposal of the Grand Council in favour of the protection of animals with due satisfaction to the demands of science was adopted by 35,191 votes to 19,551.

IT is announced in *Science* that Miss Helen Culver has signed papers giving 1,000,000 dollars to the University of Chicago, to

be used for the biological departments. This gift carries with it 1,000,000 dollars conditionally pledged by Mr. John D. Rockfeller on November 2. It is probable that a school of medicine will be established.

THE death has just occurred of Dr. George H. Kidd, distinguished for his researches and discoveries in surgery. We have also to record the death of Prof. A. von Brunn, Professor of Anatomy in Rostock University, and of Dr. Sickenberger, Professor of Botany and Chemistry in the Medical School at Cairo.

A MONUMENT to Dr. John Rae, the Arctic explorer, was unveiled on Monday, in St. Magnus's Cathedral, Kirkwall. The base of the monument is of Aberdeen granite, the pedestal of Peterhead granite, and the figure of Portland stone. The sculptor is Mr. Joseph Whitehead. On the pedestal is an inscription setting forth the dates of Dr. Rae's different geographical expeditions.

DR. W. HUGGINS, F.R.S., has been elected a corresponding member of the Berlin Academy of Sciences, and also of the American Philosophical Society, Philadelphia.

THE twenty-third annual dinner of the Old Students of the Royal School of Mines will take place on Friday, January 24. The chair will be taken by Mr. A. G. Charleton, and a number of well known men of science are expected to be present.

THE annual meeting of the Association for the Improvement of Geometrical Teaching will be held at University College, Gower Street, on Saturday, January 11. The morning meeting (at 11) will be devoted to the ordinary business of the Association. At the afternoon meeting (at 2), Dr. Larmor will read a paper on "Geometrical Methods," and visitors interested in the subject will be cordially welcomed.

WE learn through *Science* that the Astronomischen Gesellschaft has decided, because of the expense connected therewith, no longer to maintain a library. The announcement is made that the Society does not desire to receive any publications in the future, and that, with the completion of the thirtieth year of the *Vierteljahresschrift*, no exchange with other scientific bodies will be continued. Our contemporary also publishes the news that the Astronomical Observatory of the University of Berlin will probably be removed to Dahlem, to which suburb it is proposed to remove the Botanical Garden.

AN ingenious system of purifying atmosphere and regulating temperature is in operation at Chicago, for the switchboard room of the Telephone Company; where dust formerly interfered seriously with the connections on the switchboard. The air for the room is forced through a chamber, where it is thoroughly sprayed; then passed through rapidly rotating spiral coils, which strip it of superfluous moisture, and afterwards through a chamber kept at nearly uniform temperature by the use of ice or of heating apparatus, as may be required. Access to the switchboard room is through an ante-chamber; and the temperature of the room itself shows a variation of not more than two degrees in a month.

UPON application by the East Suffolk County Council, the Home Secretary has made the following order: The taking or destroying of wild birds' eggs is prohibited in the years 1896, 1897, and 1898, in the following places within the administrative county of East Suffolk—namely, the sea coast, beach, foreshore, sandhills, saltings, or salt marshes, situate between the sea or estuaries and the land side of the sea or estuarial wall, embankment, ditch, fence, or other artificial or natural boundary separating the same from the cultivated land, from the north side of the river Blyth to Landguard Point (excluding the estuary of the Alde above the ferry at Slaughden Quay, Aldeburgh).

THE Duke of Devonshire has not had to wait long for the further information which he expressed a desire to have, when the deputation waited on him on November 28 to support the appointment of a Statutory Commission for the establishment of a teaching University for London. It will be remembered that the Duke, in the course of the interview, expressed a desire for information with reference to the attitude of the graduates towards the scheme contained in the Report of Lord Cowper's Commission, and upon other points. A long memorial, signed by sixty representatives of colleges, medical schools, and other institutions, has now been forwarded to the Duke of Devonshire, as President of the Council. The memorial deals seriatim with the attitude of the graduates, the amendments proposed in the interest of external students, the suggested procedure by way of charter, and the rights of veto under the existing charter. It should assist the Duke to form an opinion as to the unreasonable and unconstitutional nature of the opposition to the scheme.

MR. LEON CLERC, Secretary of the Chambre de Commerce Française de Londres, writes as follows:—"The town of Dôle (Jura), the birthplace of Pasteur, has decided to erect a monument to that great man. A Committee, at the head of which is M. Félix Faure, President of the Republic, and many of the present Cabinet, Senators, and Deputies, has been formed, and a list of subscriptions opened throughout the civilised world. The French Chamber of Commerce in London has been requested to take the necessary steps to bring this subscription to the notice of the British public. The work of Pasteur has been fully recognised in England, where his admirers are very numerous, and many will cherish his memory to the end of their days. We feel certain that, in this universal manifestation of gratefulness towards a benefactor of mankind, Englishmen will respond liberally. Our President, M. Marius Duché, Monument House, E.C., in conjunction with the whole of our Committee, will be pleased to receive all donations, which will be acknowledged in the Press; and should any representative men desire to join our Committee, we shall be pleased to accept their aid."

DURING this month the first number of *The Journal of Experimental Medicine*, a periodical devoted to original investigations in physiology, pathology, bacteriology, pharmacology, physiological chemistry, hygiene and medicine, will be published by Messrs. D. Appleton and Co., New York. The journal will be devoted exclusively to the publication of original work in the experimental medical sciences, with special references to work done in America. It will doubtless stimulate scientific investigation, and should extend the influence of scientific medicine. The practitioner who wishes to keep abreast of the times will appreciate the value of such a publication. That the journal will be of high character, and truly representative of scientific medicine in America, is assured by the character of those whose co-operation has been secured. Dr. William H. Welch, Professor of Pathology in the Johns Hopkins University, is to be the editor of the new journal, and with him will co-operate a board of twelve associate editors, all of whom are eminent workers in scientific medicine. The journal will appear in, at least, four numbers during the year, and oftener when necessary.

ANOTHER periodical, the first number of which will appear in America this month, is entitled *Terrestrial Magnetism* an international quarterly journal to be published under the auspices of the Ryerson Physical Laboratory, University of Chicago, and edited by Dr. L. A. Bauer, with the co-operation of numerous eminent workers in terrestrial physics in many parts of the world. The journal will be devoted exclusively to terrestrial magnetism, and its allied subjects, such as earth currents, auroras, atmospheric electricity, &c. The magnetic needle has become such a promising instrument of research, not

only in terrestrial but also in cosmical physics, that the journal which is to be devoted to phenomena connected with it will appeal to a large class of investigators. To quote from the circular heralding the new publication: "No other mechanical means is so surely and so completely recording the physical history of terrestrial and cosmical changes as the self-registering magnetographs of our magnetic observatories, whereby the fitful tremors of the delicately suspended magnetic needle are being indelibly fixed on the sensitised sheet. On that paper, as Maxwell eloquently expressed it, the never resting heart of the earth is now tracing in telegraphic symbols, which will one day be interpreted, a record of its pulsations and its flutterings, as well as of that slow but mighty working [the secular variation] which warns us that we must not suppose that the inner history of our planet is ended."

THE *British Medical Journal* publishes the following list of prizes awarded by the Paris Académie de Médecine. The Barbier prize of £80, offered every year for the discovery of a remedy for an incurable disease, such as hydrophobia, cancer, epilepsy, cholera, &c., was not awarded to any of the ten competitors, but an "encouragement" of £20 was granted to M. E. Legrain for his work on the sero-therapeutic treatment of typhoid, and smaller sums were awarded to five others. The Henri Buignet prize of £60, for the best work on the application of physics or chemistry to medicine, was awarded to Dr. Chabrié for his memoir on the "Chemical Transformation of the Fundamental Substance of Cartilage during Ossification." The Adrien Buisson triennial prize of £420, offered for the discovery of a remedy for a disease hitherto looked upon as incurable, was divided among the following: £240 to Dr. Jarre for his work on the "Cure of Tic Douloureux of the Face by a New Surgical Method"; £80 to Dr. Chervin for his memoir on "Stammering and other Defects of Pronunciation"; £40 to MM. Wurtz and Marcano for their essay on "Leprosy: its Prophylaxis and Treatment"; £20 to Dr. Galliard for his work on "Pneumo-thorax"; £20 to Dr. Christiani, of Geneva, for his researches on the "Thryoid Body"; and £20 to Dr. Calvin, of the Medical Department of the French Army, for his work on "Chronic Paludism." The Chevillon prize of £60, for the best work on the treatment of cancer, was awarded to Dr. Repin for his work entitled "Contribution to the Study of a New Method of Treatment of the Malignant Inoperable Tumours: Toxitherapy." The Dauvel prize of £40 for the best work on myxœdema was divided between Dr. Combe, of Lausanne, and the Drs. Cristiani (M. and Madame), of Geneva. The Desportes prize of £52 for the best work on practical therapeutics was divided between Dr. Thibierge ("Therapeusis of Diseases of the Skin") and Prof. Delorme ("Disappearance of Neuritic Disorders, &c., by Localised and Forcible Compression"). The Huguier prize of £120 (triennial) for the best work on diseases of women, especially their surgical treatment, was awarded to Drs. S. Bonnet and P. Petit for their "Practical Treatise on Gynæcology. The Laborde prize of £200 was divided, Drs. Gouguenheim and Glover being awarded £100 for their "Atlas of Laryngology and Rhinology"; Dr. Chipault £60 for his "Operative Surgery of the Nervous System"; Prof. Reverdin, of Geneva, £20 for his essay on "Surgical Antisepsis and Asepsis," and Dr. Delbet £20 for his "Surgical Anatomy of the Bladder." A prize of £40 (Prix Adolphe Monbinne) was awarded to Dr. L. Petit for his book on "The Consumptive in the principal Countries of Europe." The Perron prize (£152) was divided among six candidates, Dr. Sabouraud getting the lion's share (£72) for his work on "Human Trichophytoses."

MR. DINSHAH A. TALEYARKHAN, who was President of the Tropical Section of the International Congress of Hygiene and Demography, Budapest, has sent us, from Baroda, two short notes referring to the discovery of the anti-toxin of snake-poison. The first of these notes was published in January 1890; but as we find no mention of a publisher or society upon it, we conclude it was issued privately, though it appears to have been brought before the medical faculty at Baroda. In the course of his paper, the author suggested that "the blood of a weasel must itself be an antidote to snake-poison," and remarked: "An alternative process may also be tried in first inoculating animal-blood with the virus of a serpent, and then preparing an extract for inoculation into the blood of a human being bit by a serpent." No experiments are described by Mr. Taleyarkhan, the object of the notes he has sent us being to call attention to his suggestions, made five years ago, and to compare them with the actions taken by Prof. Fraser.

THE question of the destruction of undersized fish and its prevention was by no means exhausted by the evidence laid before the Select Committee of the House of Commons, which was appointed to consider the subject in 1893. The evidence supplied to that Committee by the Marine Biological Association proved that the plaice of the English Channel belong to a smaller race, and reached maturity at a smaller size than those of the North Sea. Mr. J. T. Cunningham, one of the naturalists of the Association, has during the last year paid special attention to the further investigation of this subject in the North Sea, and has proved that the limits determined at Grimsby do not apply to the whole of that region. On the one hand, his evidence does not support the contention of the Germans that the plaice on their coast are a smaller race than those on the English side, but on the other hand he has found that the plaice landed at Lowestoft from the Dutch coast south of Texel are no larger than those of the English Channel, the extreme length of immature females being fourteen inches in the latter case, as against eighteen inches in the case of fish generally obtained in the North Sea. The difficulty of devising beneficial regulations to be applied to the fishing industry, while such important facts were still unknown, is sufficiently obvious.

RECENT attempts to improve the existing methods for the isolation of argon from the atmosphere have led to a closer examination of reactions in which nitrogen is directly absorbed by metals. The number of these known to be capable of readily combining with nitrogen at a red heat now includes magnesium, lithium, barium, aluminium, zinc, iron, and copper. Magnesium nitride, the properties of which were first pointed out by Brigled and Geuther, and which played an important part in the discovery of argon, is now well known, but our knowledge of other metallic nitrides is still incomplete. Metallic barium, which is readily prepared by the action of sodium at a moderately high temperature upon the double fluoride of barium and sodium, has just been shown by M. Limb (*Comptes rendus*, December 9), to absorb nitrogen energetically, and its use as a cheap means of preparing argon from air is suggested. Other nitrides have been prepared by a new method by MM. Rossel and Frank (*ibid.*). Calcium carbide, well powdered and mixed with finely-divided magnesium (aluminium, zinc, iron or copper), on heating over a Bunsen burner, with free access of air, gives calcium oxide, together with a nearly quantitative yield of the corresponding nitride. But the most remarkable results have been given by lithium. This metal was recently shown by M. Guntz to absorb nitrogen with incandescence at temperatures below a red heat. It has now been shown by M. Deslandres (*ibid.*), and M. Guntz (*Comptes rendus*, December 16), that this absorption takes place slowly in the cold. The latter exposed about ten grams of lithium over sticks of caustic soda to a slow current of air; the product after four months consisted of seventy-six parts of nitride, twenty parts of hydroxide, and only four parts of metallic lithium. M. Deslandres proved the same fact under somewhat different conditions by allowing a

confined volume of nitrogen to act on metallic lithium. The absorption was slow, but was so complete that the characteristic bands of the nitrogen spectrum entirely disappeared. M. Deslandres compares the reaction to the slow absorption of oxygen by phosphorus, and points out that as a reaction of nitrogen this is unique.

AN interesting contribution, by M. Osmond, to the existing knowledge on the molecular structure of hardened steel appears in the *Bulletin de la Société d'Encouragement* for November. He states that in highly carburised steels, containing more than 1·3 per cent. of carbon, quenched at temperatures above 1000°, there are two constituents, A and B, which differ widely in their properties. The constituent A is the ordinary, hard, strongly magnetic substance of which hardened steel containing 1 per cent. of carbon is almost exclusively composed. Its hardness is greater than that of orthoclase. B, on the other hand, is only about as hard as fluorspar, and, as far as can be judged by a study of its properties while mixed with A, is non-magnetic. M. Osmond, however, has been hitherto unable to prepare B free from A, although by quenching steel containing 1·6 per cent. of carbon at a temperature of from 1000° to 1100° in ice-cold water, he has obtained a mixture of A and B in about equal proportions. This mixture is comparatively very feebly magnetic. The constituents both contain carbon, and exist side by side in separate polyhedra. The author concludes that B is the allotropic form of iron (denoted γ), which is especially stable above 860°, and is present to the exclusion of the other forms of iron in steels containing 25 per cent. of nickel, or 12 to 13 per cent. of manganese, these steels being non-magnetic. The hard constituent A would then be the allotropic form β. The research will be hailed by the allotropists as affording most important evidence in favour of their theory.

A PAPER on the temperature variation of the thermal conductivities of marble and slate is contributed to the *American Journal of Science* by B. O. Peirce and R. W. Willson. The net result of their investigation is that such a temperature variation does not exist; in other words, that marble and slate conduct heat equally well at all temperatures. This result is of some importance to the physics of the earth's crust, and the manner in which it was arrived at displays some ingenuity. Two faces of a slab of marble or slate were kept at different temperatures, and the fall of temperature between one surface and the other was determined by means of thermopiles. Now it is notoriously difficult to determine the temperature accurately at a certain point, and borings lead to errors in estimated depth. So the expedient was adopted of slicing the slab into a series of layers pressed together, between every two of which a thermocouple was introduced. The interstices were only a few tenths of a millimetre, and experiments with different intervals proved that the error in the temperatures observed did not exceed one or two degrees Centigrade. On plotting the temperatures and distances, the temperature was found to have fallen uniformly throughout the slab. If the conductivity had been higher at higher temperatures, the fall on the hot side would have been more decided. The temperatures ranged from 350° C. to zero.

ATTENTION may be drawn to a translation, in handy form, of Prof. Hering's well-known addresses on "Memory as a General Function of Organised Matter," and on "The Specific Energies of the Nervous System." The little volume is issued by the Open Court Publishing Company of Chicago, as part of the Religion of Science Library, at a price of 15 cents.

A CONCISE account of the work of Priestley, Scheele, Cavendish, and Lavoisier, in connection with "The Discovery of Oxygen, and its Immediate Results," which appeared recently in the *Pharmaceutical Journal*, has been reprinted and published in the form of a pamphlet, obtainable at the office of our contemporary.

A "MUSEUM REPORT," containing a descriptive list of the donations to the Museum and Herbarium of the Pharmaceutical Society during 1893–94, has been prepared by Mr. E. M. Holmes, Curator of the Museum, and published by the Society. The catalogue contains interesting notes concerning the more important donations, and the complete list of donations to the Herbarium, in which the plants and plant products are arranged in alphabetical order, should prove of practical value.

THREE new volumes have lately appeared in the comprehensive Aide-Mémoire series published jointly by MM. Gauthier-Villars and G. Masson, Paris. One is "Applications Scientifiques de la Photographie," by M. G. H. Niewenglowski. We have long expected the publication of a book on this subject, but the one now before us is satisfactory. No account is given of the remarkable results obtained in astronomical photography, and the photography of solar and stellar spectra is only mentioned in a few words. In fact, the author has not treated his subject in the broad scientific manner it deserves, and there is yet room for some one to write a really good treatise on it. The volume by M. X. Rocques entitled "Analyse des Alcools et des Eaux-de-vie," just published in the same series, should prove of service to analytical chemists; while the third of those lately received—"La Topographie," by Lieut.-Colonel P. Moëssard, is an excellent manual on maps and their construction, containing concise descriptions of triangulation, levelling, and cartography.

THE last number of the *Bollettino* of the Italian Seismological Society contains an interesting paper by Dr. G. Agamennone, on the earthquake of Paramythia (Epirus) during the night of May 13–14, 1895. The official accounts state that 269 houses were destroyed, and 262 more were rendered uninhabitable; that seventy persons were killed and fifty wounded; but Dr. Agamennone believes that these figures refer only to the district of Paramythia. The area including all the villages where houses were damaged is elliptical in form and contains about 400 sq. km., the longer axis being directed N.N.E. and S.S.W. The centre of this area lies near the villages of Dragani and Carvounari, where the intensity of the shock was between ix. and x. of the Rossi-Forel scale. In this district, the ground was fissured in several places. The shock was felt, though slightly, at Zante, which is 180 km. from the epicentre; and the pulsations were registered by several of the Italian seismographs, and also by the horizontal pendulum at Nicolaiew, about 1250 km. from Paramythia.

THE additions to the Zoological Society's Gardens during the past fortnight include a Burchell's Zebra (*Equus burchelli*, ♀) from South Africa, presented by the Hon. W. Rothschild; a Common Badger (*Meles taxus*), British, presented by Mr. Thomas B. Place; a Rough Fox (*Canis rudis*) from Demerara, presented by Captain J. Ernst; a Blue and Yellow Macaw (*Ara ararauna*) from Brazil, presented by Mrs. Alec. Tweedie; two Hoary Snakes (*Coronella cana*), two Puff Adders (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; an Anamolous Snake (*Coronella anamola*) from Brazil, presented by Mr. Frank Summers; a Nilotic Monitor (*Varanus niloticus*) from North Africa, deposited; two Ornamental Lorikeets (*Trichoglossus ornatus*) from Moluccas, two Forsten's Lorikeets (*Trichoglossus forsteni*) from Sumbawa, purchased; a Cactus Conure (*Conurus cactorum*) from Brazil, received in exchange; a Southern River-Hog (*Potamochœrus africanus*) from East Africa, presented by Mr. Henry M. C. Festing; a Golden Eagle (*Aquila chrysaëtus*) from Scotland, presented by Mr. Osgood H. Mackenzie; a White-crowned Mangabey (*Cercocebus æthiops*, ♂), a Green Monkey (*Cercopithecus callitrichus*, ♂) from West Africa, deposited; two Red-sided Tits (*Parus varius*) from Japan, purchased.

OUR ASTRONOMICAL COLUMN.

ROTATION OF JUPITER.—Most of the determinations of the rotation period of Jupiter have been made by observations of surface markings between latitudes 45° N. and 35° S., and little has been known as to the conditions of rotation near the poles. This is due to the fact that conspicuous and sufficiently definite spots are chiefly confined to the equatorial regions of the planet, and partly to the unfavourable conditions under which the poles are presented to us. Some important observations, however, bearing on the rotation in high latitudes, have been secured by Mr. Stanley Williams with the aid of a $6\frac{1}{2}$-inch Calver reflector (*Ast. Nach.*, 3325). On October 10, 1892, a short dusky streak, almost oblong in appearance, was observed quite close to the north limb of Jupiter, and reaching at least as far as 85° N. Other streaks of similar appearance were subsequently observed, and frequent observations of the times of mid-transit were made. Confirmation of the results has been obtained by an examination of several photographs of the planet taken at the Lick Observatory about the same period, the markings being sufficiently distinct for measurement. Generally speaking, the visual agree very closely with the photographic results, the mean rotation period derived by the two processes only differing by about two seconds. The mean result for the rotation period of the surface material of Jupiter, between north latitudes 40° and 85°, is 9h. 55m. 38·9s. ± 1·20s., this being the length of a sidereal rotation expressed in mean solar time. The following statement illustrates the degree of accuracy obtained:—

	h.	m.	s.		s.	
Spot *a* ...	9	55	33·7	±	1·32	(77 rotations)
Spot *b* ...	9	55	43·8	±	2·25	(41 ,,)
Spot *c* ...	9	55	39·7	±	0·60	(252 ,,

Mr. Denning's value for a spot in latitude 35° N., namely, 9h. 55m. 39s., agrees very closely with the foregoing, and differs by only a few seconds from the period deduced from observations of the red spot.

Supplementary details, which are given by Mr. Williams, indicate that the positions of markings on Jupiter may be determined with quite as much accuracy from photographs as by the best micrometrical measurements in the telescope.

THE PARALLAX OF α CENTAURI.—As part of a discussion of the meridian observations of α Centauri, made at the Cape Observatory during the years 1879–1881, Mr. A. W. Roberts has deduced a new value for the parallax of this interesting system (*Ast. Nach.*, 3324). Mean places for the two components have been computed by applying corrections for proper motion and orbital motion, and assuming a parallax of 0″·75. The errors of a systematic nature, which cannot be certainly accounted for, are believed to be due to an erroneous value of the refraction depending upon the temperature. Disregarding these, and adopting the aberration constant determined by Chandler, 20″·50, the parallax of α Centauri, from declination measures alone, was found to be 0″·81 ± 0″·05. From the right ascension measures alone, the value 0″·66 was calculated. Solving for both coordinates, the resulting value for parallax is 0″·71 ± 0″·05. This corresponds to a little over $4\frac{1}{2}$ light-years and shows a marked agreement with the parallax 0″·75 found by Drs. Gill and Elkin in 1882 from measures made with the heliometer.

NEW VARIABLE STAR OF THE ALGOL TYPE.—*Harvard Observatory Circular*, No. 3, announces that the star B.D. + 17°·4367, magnitude 9·1, and approximate position for 1900, R.A. 20° 33′·1, Decl. + 17° 56′, is a variable of the Algol type. The change in brightness appears to be rapid, and the range of variation to exceed two magnitudes.

THE NATURE OF THE PHYSIOLOGICAL ELEMENT IN EMOTION.

PROF. A. C. WRIGHT contributes an interesting paper "on the nature of the physiological element in emotion" to *Brain* (parts 70 and 71), the object of which is to apply the results obtained by Gaskell's observations on somatic and splanchnic nerves to the study of the emotions. Prof. Wright begins his paper by taking as an example the phenomena observed in a kitten confronted with a strange dog, and shows that such an emotional stimulus would call forth in the kitten a regular series of reflex responses: first of all, through the involuntary visceral efferent nerves; then the semi-involuntary muscles, such as those of the face, would be called into action; and, lastly, there would be reflex response of certain parts of the voluntary muscular system. The essential features to be recognised in this example and in every emotional reaction are—the origination of the emotion in a violent sensory stimulus, a condition of extreme neural tension in the reflex centre, and an overflow of neural energy into different paths. This overflow takes place first into channels associated with involuntary muscle, then into those associated with semi-voluntary muscle, and lastly into those associated with voluntary muscle. The physiological essence of the emotion is to be found not in the visceral reflex actions, but in the high neural tension of the reflex centre which gives rise to these actions. In childhood sensory stimuli call forth in each case responses both of involuntary and voluntary muscle, while with increasing age the outflow of neural energy from the reflex centre becomes more and more restricted to paths associated with voluntary muscle. As a result of such transformation we get purposive voluntary action. The author notices the *à priori* necessity for some system of control of the reflexes, since "if each minimal stimulus were to evoke a separate reflex movement in an organism which was endowed with a sensitiveness at all approaching that of the human organism, life would be a mere chaos of muscular movement." Voluntary muscles react to the slightest stimuli, but involuntary muscular actions are only called out by intense stimuli, or by a summation of slighter ones. High neural tension in the reflex centre is therefore necessary for these reactions of involuntary muscles, and all such high neural tension is attended with a sense of distress. The replacing of the "generalised somatico-visceral reflexes of inexperience and childhood by the specialised purposive reflexes of experience and adult life" . . . "is not so much a question of substituting one variety of reflex for another, as it is a question of substituting a condition of low neural tension for a condition of high neural tension."

PHOTOGRAPHY AND CHRONOGRAPHIC MEASUREMENTS.[1]

IN chronographic measurements in physiological experiments, photography has been in constant use for several years, and the methods are well known. I have extended recently the method of what may be called photographic chronography to measuring the velocity of projectiles. On former occasions I have shown that to obtain the best chronographic results, magnetic and solenoidal arrangements should be avoided, since by their use a time lag is introduced. The following chronographic method depends entirely on light. Two sources of light at a suitable distance apart throw two beams of light on to a sensitive plate, carried on the carriage of a tram chronograph. By means of lenses, the beams of light are caused to form two sharp images on the plate in a vertical line, one above the other; a tuning-fork trace is also made on the plate; if the plate traverses, when the beams of light are not interrupted, on development, two black parallel lines appear on the plate; but if, during the passage of the plate, the beams of light are cut by any solid object which shuts off the light, then on development two gaps are seen to exist. The distance between these markings when interpreted in terms of the fork trace, give the velocity of the object which cuts through the beam of light. The method was illustrated by allowing a projectile to pass through the focus where the convergent beams of light from two sources of light cross.

Another method was also shown in which the projectile cut through two thin screens placed in the paths of the beams of light, and so opened a passage for the light. In this case two parallel lines are found on the plate, one longer than the other; the difference of their lengths, when duly interpreted, gives the velocity of the projectile; when the distance between the screens is considerable, the beams of light have to be reflected on to the chronograph by mirrors. FREDERICK J. SMITH.

[1] A Note on a Lecture given at Oxford, October Term, 1895.

ATMOSPHERIC ELECTRICITY.[1]

It is hardly possible to imagine that the first experimenter who obtained an electric spark sufficiently strong to produce a sensible sound should not at once have been struck by the fact that he was in the presence of thunder and lightning on a small scale. We find, indeed, in various writings from the early days of electrical machines a number of suggestions that the thunderstorm is an electrical phenomenon; but to Benjamin Franklin belongs the merit of having perceived that a direct experiment was needed to prove what so far was only a guess. In an article entitled "Opinions and Conjectures concerning the Properties and Effects of the Electrical Matter arising from Experiments and Observations made at Philadelphia, 1749," the following passage occurs:—

"To determine the question whether the clouds that contain lightning are electrified or not, I would propose an experiment to be tried where it can be done conveniently. On the top of some high tower or steeple place a kind of sentry-box, big enough to contain a man and an electrical stand. From the middle of the stand let an iron rod rise and pass, bending out of the door, and then upright 20 feet or 30 feet, pointed very sharp at the end. If the electrical stand be kept clean and dry, a man standing on it, when such clouds are passing low, might be electrified and afford sparks, the rod drawing fire to him from a cloud.

"If any danger to the man should be apprehended (though I think there would be none), let him stand on the floor of his box, and now and then bring near to the rod the loop of a wire that has one end fastened to the leads, he holding it by a wax handle: so the sparks, if the rod is electrified, will strike from the rod to the wire, and not affect him."[2]

The experiment suggested by Franklin was successfully performed in Marly (France), by D'Alibard, on May 10, 1752,[3] in London by Canton, in Spital-square, on July 20, 1752, and by Wilson, in Chelmsford, Essex, on August 12 of the same year. Franklin himself describes having used a kite in Philadelphia in a letter dated October 19, without giving the date of his observations. But this must be supplied in some passage which I have not been able to find, for Rosenberger ("Geschichte der Physik," vol. ii. p. 316) mentions that it was done in June.

Franklin's disbelief in the dangerous character of the experiment must have received a severe shock when he heard of the death of G. W. Richmann, who, in the year 1753, was killed by an electric discharge drawn from the clouds by means of a kite.

The thunderstorm is the most impressive effect of atmospheric electricity, though it is rivalled in beauty by the aurora, and in interest by the many phenomena of daily occurrence, which are only made perceptible to us by proper instruments. In a lecture delivered before this Institution on May 18, 1860, Lord Kelvin described the delicate electrical appliances constructed by him for the more accurate observation of atmospheric electricity. The problems then for the first time clearly stated, gave a powerful and still lasting impulse to the investigation of atmospheric electricity, and though no decisive answer can be given to all the questions raised in that lecture, recent researches have brought us somewhat nearer to their solution.

Observations which may be made every day and at every place have shown that the earth is electrified, whatever the weather may be. In the language of the older theories, which we cannot as yet altogether abandon, we say that the earth is covered with negative electricity, or, in modern phraseology, we express the same idea by the statement that we move about in an electrified field, that electric lines of force stretch through the air from the ground, from our bodies, and from everything which is exposed to the sky overhead. The strength of this electric field is not at all insignificant. If we wish to produce it artificially between two parallel plates kept at a distance of one foot, we should have to apply an electromotive-force sufficient—and sometimes more than sufficient—to light up the incandescent lamps which illuminate our dwellings. The electric force is comparatively weak in our country, but 50 volts per foot are constantly observed, and 100 volts are not uncommon; but in dryer climates the amount of the force may be considerably in excess of these figures.

[1] Discourse delivered before the Royal Institution of Great Britain, by Prof. Arthur Schuster, F.R.S.

[2] "Experiments and Observations on Electricity made at Philadelphia, in America," by Benjamin Franklin, LL.D. and F.R.S. (London, printed for David and Henry, and sold by Francis Newbery, 1769, p. 66.)

[3] *Ibid.*, p. 107.

If we fix our minds on the lines of force starting from the surface of the earth, we are at once led to ask, Where is their other end? Do they curve round and back again to earth? Do they end in the dust which everywhere surrounds us, or do they reach up to the clouds? Do they pass through the clouds and end where invisible particles separate the sunset red from the midday blue? Or, finally, do they leave the earth altogether, and form intangible bonds between us and the sun, the stars, the infinity of space? These are not idle questions, and we cannot be said to have solved our problem unless some definite answer is given to them. The last-mentioned view, propounded originally by Peltier, and latterly supported by Exner, is the simplest. If we could allow that the earth, once electrified negatively, could remain electrified for ever, the corresponding positive electrification being outside our atmosphere altogether, the chief difficulty of atmospheric electricity would be removed, and the normal fall of potential at the surface would be explained by the permanent negative electrification of the surface.

Unfortunately this view, to be tenable, has to assume that the atmosphere is a complete non-conductor to the normal electric stress, and this is known not to be the case. We know of several causes which break down the insulating properties of air. If two pith balls are electrified and repel each other, and a match be lit in their neighbourhood, the pith balls come together, showing that they have lost their charge, and consequently that the flame of the match has destroyed the insulating power of air. It is not only the flame itself which conducts, but also the gases rising from the flame.[1] The following experiment will prove this. In Fig. 1, A represents a metallic tube bent round at the upper end, and containing at its lower end a Bunsen burner in metallic contact with the tube, which is also connected to an electroscope. The tripod, T, which supports the tube, is insulated by blocks of paraffin. A Leyden jar, L, on a separate support, is placed so that the knob stands at about the level of the upper part of the tube, which acts as chimney to the flame. The knob of the jar may be a few inches away from the opening of the chimney, and not necessarily in a line with it. The experiment succeeds, although the gases rising from the burner may not come into contact with any part of the jar. The jar is charged, and care must be taken that no fibres of dust attach themselves either to the jar or chimney. I have found it convenient to join a piece of amalgamated zinc to the end of the chimney. Under these circumstances the charge of the jar will be found to leak across to the tube, and the leaves of it will diverge. If, as in Exner's form of electroscope, the leaves, on reaching a certain divergence, discharge by forming a

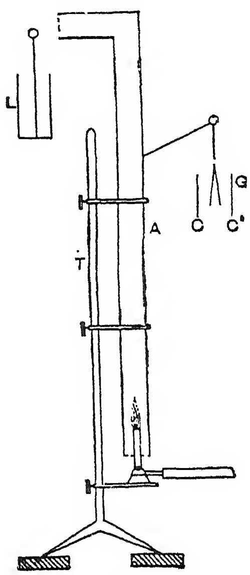


Fig. 1.

[1] The most complete investigation of the conduction of gases rising from flames is contained in a series of papers by Giese (*Wiedemann's Annalen*, vol. xvii.).

contact with earth-connected plates, C C′, the charging and discharging can be watched for a long time. It will be noticed that the flame, being altogether surrounded by a tube of the same potential, cannot be active in this case, but the conductivity must be due to the gas as it escapes from the chimney.

It follows from these experiments that every fire burnt on the surface of the earth, and every chimney through which products of combustion pass, act like very effective lightning conductors, and would consequently discharge, slowly but surely, any electrification of the surface of the earth. The peculiar immunity of factory chimneys against damage by lightning appears from statistics collected by Hellmann in Schleswig-Holstein,[1] for while 6·3 churches per thousand were struck, and 8·5 windmills, the number per thousand of factory chimneys was only 0·3.

Franklin was acquainted with the action of flames; he also discovered that no charge can be given to a red-hot iron ball, a fact which seems to have been forgotten until re-discovered in our own times by Guthrie. Franklin also tried the action of sunlight, but obtained no result. Had he performed the experiment with carefully-cleaned zinc, he would have anticipated one of the most striking of Hertz's discoveries. We now know that a negatively-charged surface will discharge into air when illuminated by strong violet light, and sunlight will be sufficient with specially sensitive materials. This action has been investigated in detail by Elster and Geitel, who have not, however, succeeded

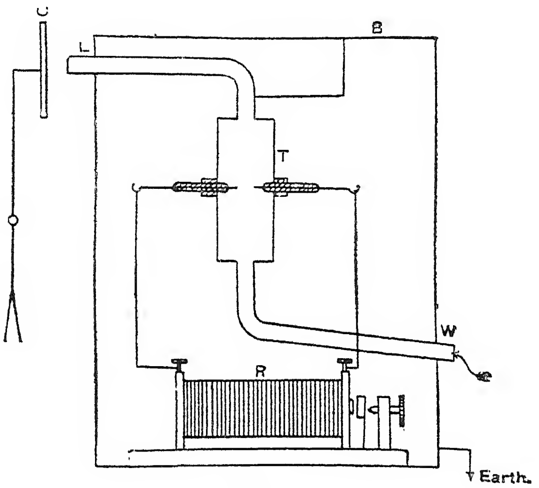


FIG. 2.

in obtaining results with sunlight acting on such bodies as we know the earth's crust to be made of. So far, then, we have no experimental evidence to include light as an active agent in the phenomenon of atmospheric electricity.

We possess in the electric discharge itself a very powerful, and probably very generally active means of breaking down the insulating power of air. Some of the experiments (*Proc. Roy. Soc.*, vol. xlii.) which I described some years ago to prove this, were objected to on the ground that it might not be the discharge itself, but the ultra-violet light sent out by the luminosity of the discharge, which was active. The following form of the experiment conclusively shows that the discharge acts independently of light.

In Fig. 2, R represents a Rhumkorff coil entirely surrounded by a metallic box, B, which is connected to earth. The terminals of the coil lead to two electrodes inside a metallic tube, T, which is also kept at zero potential. This tube is arranged so that a current of air can be blown through it. The air, on escaping through the tube, is made either to impinge on or to pass near a metallic plate connected to a charged electroscope. Under these circumstances, the electroscope is not discharged either by a current of air alone, or by the coil alone. But as soon as the air is blown through the apparatus while the sparks are passing and then made to impinge on the plate C, the electroscope is instantaneously discharged. The experiment succeeds when a plug of cotton-wool is inserted at W, to stop the action of the dust; but a plug of cotton-wool at the other end diminishes the action so much, that I am doubtful whether the effect then really exists there. I am, so far, not inclined to believe that the action is due to dust, but rather that the cotton-wool acts in increasing very considerably the interval which elapses between the time at which the spark acts and the time at which the sparked air passes out of the tube. The effect may be observed even though the tube L is lengthened by an addition of another piece 3 feet or 4 feet long.

Several phenomena, one of which had been known for a long time, can be explained by the fact that the electric discharge changes the condition of the gas into a state similar to that of gases rising from flames. It is mentioned, for instance, by Faraday that electric sparks are liable to succeed each other along the same path, and it is known that the same holds for lightning flashes, facts which themselves point to a higher conductivity of air along the path of the previous discharge. A curious instance of a similar effect is afforded by lightning conductors, which are sometimes put up to protect overhead leads used for conveying a high tension current. Owing to the obvious impossibility of connecting the leads directly to earth, a small air gap is interposed, the idea being that the air gap will act as an insulator for the current the leads are intended to carry, but that if during a thunderstorm the potential rises sufficiently high to be dangerous, equalisation may take place through the air gap to earth by means of a small spark. So far, the air gap answers its purpose, but as soon as a spark passes through the gap, it destroys the insulating power of the air, and the main current consequently takes a short-cut through the gap. At Pontresina, in the Engadine, lightning conductors put up in this way are so sensitive that a flash of lightning several miles away causes a small spark by induction, and instantaneously puts out every electric lamp in the town.

If we accept the view that an electric discharge destroys the insulating power of the gas, it follows that the outer regions of the atmosphere must conduct, for we have ample reason to suppose that electric currents are passing continuously through those regions. The aurora borealis in the arctic regions is, according to Nordenskiöld's observations, a permanent phenomenon, and the diurnal changes of terrestrial magnetism show that in our latitudes electric currents traverse the air above us. However small a conductivity we may assign to the atmosphere, the earth could not remain electrified inside such a shell of partially conducting gases. Lord Kelvin drew the same conclusion in the Royal Institution lecture, on the assumption that gases at much reduced pressures cease to insulate. We may leave it an open question whether the normal electric stress could in itself cause a discharge in the outer regions; but we cannot deny that under existing conditions these regions do not insulate, and Lord Kelvin's argument still holds good.

But the question of the ending of the lines of force—in other words, the location of the positive charge corresponding to the negative electrification of the surface of the earth—can only be solved by balloon or kite experiment, and we may briefly mention the more important results which have so far been obtained.

Observations made up to heights of about 1000 feet seem to indicate a strengthening of the electric field—*i.e.* the fall of potential per metre is greater at a height of, say, 200 metres than on the surface of the earth. The observations of Dr. Leonhard Weber (*Elektrotechnische Zeitschrift*, April 1888) bring out this point clearly. In one case the fall of potential at a height of 350 metres was found to be six times that at the earth's level. This increase is in itself not surprising, if we remember that every particle of dust raised from the ground must itself be negatively electrified, and probably the observed increase in the electric force is sufficiently accounted for by the presence of electrified dust.

Observations made at greater heights in balloons, on the other hand, seem clearly to indicate that this increase soon ceases, and that a diminution already takes place at moderate heights. Thus the observations of Dr. O. Baschin (*Meteorologische Zeitschrift*, September 1894) gave for the fall of potential in volts per metre the numbers 49, 28, 13 at heights of 760, 2400, 2800 metres respectively, and at a height of 3000 metres no measurable fall at all could be obtained. These observations were made in clear weather. The balloon afterwards passed over a layer of clouds, and strong electric effects were noticed. Similar observations had been previously made by

[1] "Veroffentl. des Kgl. Preuss. Stat. Bureaus," 1886, p. 177, quoted by Bebber, "Meteorologie," p. 245.

others (Andrée, Le Cadet, and Bornstein), and though the subject is by no means exhausted, we may take it as provisionally established that the lines of force of the normal electric field of the earth end within the first 10,000 feet or 15,000 feet. This result is of great importance, for it shows that in fine weather there must be a layer of positively electrified air permanently above us. Currents of air in this layer must affect the field as we observe it, and possibly the daily period may be due to changes in the currents of air at a moderate height. A fact discovered by Exner is of importance in connection with this subject. Observing at three different places (in a field close to Vienna; in St. Gilgen, on the Wolfgangsee; and on the hills near Venice), he found that whenever there was a strong south wind, with a clear sky, the normal electric force was always increased, and sometimes considerably (*Wiener Akad. Sitzungsberichte*, vol. xcvi., 1887).

The daily changes show, with few exceptions, a remarkable uniformity at different places. There are in general two maxima of potential—one at 8 or 9 o'clock in the morning, and one in the evening. The evening maximum is the most marked, while at some places, and especially near towns, the morning maximum disappears. The same general features of the daily variation have been found to hold at a number of European stations, at Cape Horn, Melbourne, and in the Northern Arctic regions. If the variation is separated into two—one having a period of 24 hours, and the other of 12 hours—the latter is found to agree in phase at widely different places on the earth's surface, while the former is found to vary to a much greater extent, and hence to be probably more affected by local circumstances. The remarkable researches of Hann have given a similar result for the diurnal variations of the barometer, and we may reasonably conclude that the semidiurnal variation of atmospheric electricity is connected with the same circulation in the upper regions of the atmosphere which shows itself in the corresponding changes of pressure.

In addition to the more regular periodic changes, the electric stress observed in fine weather shows marked differences on different days and at different seasons. With respect to these, the researches of Prof. Franz Exner (*ibid.*) have led to the important result that there is a close connection, direct or indirect, between the amount of aqueous vapour present in the atmosphere and the fall of potential observed at the surface of the earth. If p_0 be the pressure of aqueous vapour present in centimetres, Exner deduces the equation for electric force P

$$P = \frac{A}{1 + kp_0},$$

where $A = 1300$, $k = 13{\cdot}1$.

The formula agrees very well with observations in which the vapour pressure varied between 0·23 and 0·95, and it is especially to be remarked that it is the amount of vapour and not the humidity which determines the electric force. Observations made by Mr. E. Drory during a journey round the world fit in very well with Exner's formula, and observations made at such widely different places as Suez, Albany, Sydney, Colombo, and Penang showed a fall of potential practically identical with that calculated from the above formula, though the same constants were taken and the vapour pressure varied between 0·8 cm. and 2·2 cm.

Messrs. Julius Elster and Hans Geitel (*Wiener Akad. Sitzungsberichte*, vol. ci., 1892) have followed up this research. Their investigations have shown a satisfactory agreement with Exner's formula, if the mean values of a number of observations in which the vapour pressure is approximately the same, is considered. But individual numbers differ very widely from the mean, so that the formula cannot be used to predict the normal fall of potential on any particular day. There is, perhaps, nothing surprising in the great divergence of such individual results if it is considered that we only observe the moisture near the surface of the earth, but are ignorant of the total amount of water in the column of air over the district in which the observations are carried out. The same authors have shown that an equally good agreement can be obtained if, instead of the amount of aqueous vapour, we take the intensity of active radiation as the determining circumstance. The light might be supposed to act on the general surface of the earth, as it does according to Hallwachs' observations on a metallic body, dissipating a regular charge. There are some difficulties in the way of this explanation, the most serious being the absence of experimental evidence that sunlight actually does act in the manner indicated on any substance forming part of the earth's surface. It is impossible at the present time to enter more fully into this subject, but attention must be drawn to the very important indirect result, that there seems to be a connection between ultra-violet radiations and the amount of aqueous vapour present in the air.

The phenomena of atmospheric electricity have been studied at the mountain observatory established on the "Sonnblick," in Salzburg, at a height of 3100 metres.

The important result has been established that the electric force is singularly constant. The great differences observed at low level between the electric field in summer and winter, or on dry and wet days, seems to be completely absent, and these facts tend to support the conclusion derived from balloon observation. that the positive ends of the lines of force are situated at a height of something like 10,000 feet.

Brief allusion must be made to some of the causes which alter to a marked extent the normal fall of potential. As the surface of the earth is negatively electrified, it follows that dust carried up by the wind must be electrified, and it is found, indeed, that in violent dust storms the laws of force near the surfaces are altogether distorted and reversed in direction. Werner Siemens (*Pogg. Ann.* cix., 1860; *Meteorologische Zeitschrift*, 1890, p. 252) could, while standing on the top of one of the pyramids during a strong wind, charge an improvised Leyden jar sufficiently to obtain strong sparks. A casual observation of Elster and Geitel (*Ziele und Methoden*, p. 11) may prove significant. On March 7, 1889, the temperature in Wolfenbüttel was rising from -10° C. to $+2^{\circ}$ C., a cirrus layer covering the sky. The fall of potential changed in the course of four hours from 1302 volts per metre to -1200 volts, that is. from a very exceptionally high fall to an equally strong gradient in the other direction. Although the atmospheric circumstances were anomalous, they seem in themselves not sufficient to account for the anomalous electrical effects, and the authors suggest that a possible explanation may be found in a violent dust storm which on the previous day was observed in Alexandria.

Fogs are generally found to increase the normal fall considerably, so that the drops of water must be taken as positively electrified.

Waterfalls considerably disturb the electric condition of the air in their neighbourhood, the air surrounding the fall being charged negatively, sometimes to considerable distances.

Whether clouds in themselves are always electrified is very doubtful; they no doubt disturb and generally weaken the fall of potential at the earth's surface, but this may only be due to a displacement of the positively-electrified layer which balloon observations have shown to exist at a height of from 10,000 feet to 20,000 feet. While a cloud discharges rain, the electrical effects in the neighbourhood of the place are the same as that in the neighbourhood of a waterfall. The explanation is probably the same in the two cases, and by means of experiments, alluded to further on, we may reproduce the negative electrification of air under similar circumstances.

Measurements of the electrification of falling rain or snow, simple as they appear at first sight, are beset with very serious difficulty. We owe the most complete investigation on the point to Messrs. Elster and Geitel (*Wiener Sitzungsberichte*, vol. xcix., 1890). They find no regularity in the electrification, though positive signs slightly preponderate with snow and negative signs with rain.

The approach of a thunderstorm announces itself by characteristic cumuli clouds, and the general atmospheric condition favourable to their formation is felt by many persons of nervous temperament. Many of us are accustomed to hear that "there is thunder in the air." Whatever the special feeling of "thunder" may be due to, it cannot be an electrical effect, for electrical instruments delicate enongh to detect a small fraction of the normal force, give no indications of the approach of a thunderstorm, and it is only when the cloud has begun to discharge rain or hail that strong electrical effects are noticed. During the thunderstorm the electroscope is, of course, much disturbed, and there are frequent and violent reversals of its indications.[1] The fact that no effects are observed at the surface of the earth during the approach of a thunder-cloud does not prove that there is no electrical separation, for we may imagine two oppositely electric layers at different levels producing a strong

[1] Weber, *Elektrotechnische Zeitschrift*, vol. x.; Elster and Geitel, "Ueber einige Ziele und Methoden Luftelektrischer Untersuchungen," Wolfenbüttel, 1891.

electric field between them, but only weak effects outside. That some such things may possibly occur is indicated by observations made in mountain districts, where violent electrical disturbances are observed previous to the formation of clouds (Trabert, *Meteorologische Zeitschrift*, 1889, p. 342). The cumulus cloud, from which the lightning strikes out, is nearly always associated with a cirrus layer above it, and the flash occurs more frequently upwards or sidewards between the clouds than down to earth. Under such circumstances it is clear that instruments on the surface of the earth can only very partially indicate the nature and distribution of electrical stress in the neighbourhood of the cloud.

Thunderstorms seem always to be connected with a vortex motion, and meteorologists distinguish two kinds of thunderstorms. The first kind forms in the outlying portions of a large cyclonic system. The storms which occur in winter are mostly of this nature, and the vortex necessary for its formation is of the nature of a secondary disturbance. The thunderstorm which forms in summer, on the other hand, makes its own vortex, and is of a much more local character than that which is produced round a previously established barometric depression. The summer storm is much influenced by the character of a district. There are certain configurations apparently favourable to its formation, as is clearly brought out by the charts which have been made representing their frequency.

The route travelled over by the storm is affected by mountain ridges, and rivers also seem to offer a peculiar impediment. Many of them are brought to an end either along their whole front, or only part of it, when they reach the banks of a large river.[1]

Some curious problems are presented by the detailed structure of lightning flashes. Although these lie outside the range of the present lecture, reference must be made to the very beautiful photographs of lightning flashes taken both in this country and abroad. The ordinary forms which lightning takes are familiar to all; but a good deal of mystery still surrounds the so-called globular lightning. The manner in which this form appears is best described in the words of eye-witnesses.

Dr. A. Wartmann gives to the Physical Society of Geneva the following account of what he saw:[2]—"At half-past six o'clock in the evening I drove from Versoix to Genthoud. On the Malagny road I heard the coachman say he did not know where he was. His eyes were so much fatigued by the frequent and intense lightning discharges, that he was blinded, and could not, even in the intervals, see the road, in spite of the good lanterns alongside. I stepped on to the box and took the reins. We had barely passed the principal gate of the grounds of Dr. Marcet, when I became conscious of a bright and lasting luminosity behind me. Thinking it was a fire, I turned round, and saw, at a distance of, roughly, 300 metres, a ball of fire of about 40 cm. diameter. It travelled in our direction with a velocity about equal to that of a bird of prey, and left no luminous trail behind. Just as the ball had overtaken us, about 24 metres to our right, it burst with a terrific noise, and it seemed to me as if lines of fire started from it. We felt a violent shaking, and remained blinded a few seconds. As soon as I regained power of distinguishing objects, I saw that the horses had turned at a right angle to the carriage, with their chests in the hedge, with drooping ears and all signs of great terror. I returned on the following day to the place where I had seen the ball explode, but could find no sign of any damage. At a distance of 100 metres I found that a group of three trees, bordering a wood, had their upper branches singed, but it is not possible to say whether this was due to the discharge which I had seen."

The following is a translation of an account given by Mr. H. W. Roth (*Meteorologische Zeitschrift*, 1889, p. 231):—"During the thunderstorm of May 19, 1888, at about 6 p.m., a flash of lightning took effect which seems to me remarkable from a physiological point of view. The dealer Werner, from Ellerbruch, and his son (sixteen years old), with a one-horse conveyance containing rags, were on the road which leads from here to the village of Ottensen, about three miles away in a southwesterly direction. The father had been left a little behind, and the son was occupied in giving bread to the horses, when he found himself suddenly surrounded by light, and noticed a fiery ball, about the size of his fist, moving towards him along the back of the horse. Then he lost consciousness. He felt no concussion. The father, on approaching, saw the horse's limbs still contracting, and at first he thought his son was dead, but succeeded, after considerable efforts, in bringing him back to life in about three-quarters of an hour. The horse was dead."

Some curious statistics have been collected, especially in Germany, as to the damage done by lightning flashes. That damage seems to have increased to an enormous extent within the last fifty years, and although in cases of this kind statistics may easily be at fault, there seems no doubt about the reality of the fact, which may find an explanation in the partial cutting down of forests in those parts where thunderstorms chiefly occur. When lightning strikes into forests, it selects certain trees by preference. Thus, in the principality of Lippe, taking the percentage of beeches struck by lightning as unity, that for other trees is as follows:—Oak 48, spruce fir 5, Scotch fir 33.

The St. Elmo's fire, a continuous discharge from points and sharp angles, is often observed on board ship and in mountain districts during a storm. Its appearance was considered a sign of the approaching end of the lightning, and was looked upon with favour by the ancient sailors in the Mediterranean Sea, who gave to it the name of Castor and Pollux. There was another appearance called Helena, a bad omen, which by many is believed to have been another form of the St. Elmo's fire, and the present name has been stated to be a corruption of the word Helena. Some support is given to this view by the fact that the Emperor Constantine built a castle in the Pyrenees, which he named after his mother, Helena, and this castle seems to be referred to occasionally as St. Elne or St. Elme. But it is much more probable, as argued by Dr. F. Piper (*Pogg. Ann.*, vol. lxxxii. p. 317), that the word is derived from St. Erasmo, a bishop who came from Antiochia, and suffered a martyr's death at the beginning of the fourth century. He seems to have been specially considered the patron of Italian sailors. Churches and castles in Naples and Malta were called St. Erasmo and St. Ermo, and Ariosto describes St. Elmo's fires as St. Ermo's fires. The electric discharge which goes under this name has a different appearance according as it is the positive or negative electricity which escapes, and both kinds occur with about equal frequency.

Although we have not yet arrived at any satisfactory theory of atmospheric electricity, some progress has been made, and this account would not be complete without a short account of the views taken by men of science on the subject. The number of theories proposed is very considerable. Dr. Suchsland,[1] in a pamphlet published in 1886, gives an account of twenty-four, to which he adds one—his own. The year 1884 alone has given birth to four theories.

We may group the theories according to the origin they assign to the source of energy which is involved in the formation of the electric field. All the work we can perform is either derived from the sun or from the earth's rotation. There is, as far as I know, only one theory—that of Edlund—which makes the earth's rotation in space responsible for the separation of electricities in the atmosphere. But Edlund's views are not tenable in theory, and, even granting his deductions, the normal fall of potential should, according to the views of the author, have a different sign in the polar and equatorial regions, which is contrary to the observed fact. This theory does not, however, exhaust the possibility of explaining atmospheric electricity as a phenomenon of electromagnetic induction, and it is not disproved that in some form or other the rotation of the earth's magnetic field may play a part in the origin of the electric field. The theories which take solar radiation as the source of the energy divide themselves into several groups. We may think of a direct thermo-electric or actinic action, but there is, so far, no experimental support to such views. One of the earliest and most natural suppositions is the belief in evaporation as a source of electrification. This was Volta's theory, and experiments have at various times been produced in its support; but, so far, no one has been able to invalidate Faraday's conclusion that whenever electrification seemed to appear as a consequence of evaporation, it was really due to secondary causes, such as the friction of the liquid spray against the sides of the containing vessel. Rejecting Volta's theory, there is nothing left but the belief in some form of contact or frictional electricity either between drops of water and air, or water and ice, or any two of

[1] Bebber, "Meteorologie," p. 255; Bornstein, *Archiv der Seewart*, viii., 1835.

[2] *Arch. des Sci. Phys. et Nat.* (3) vol. xxi., 1889. The above account is translated from the *Meteorologische Zeitschrift*, 1889.

[1] "Die Gemeinschaftliche Ursache der Elektrischen Meteore und des Hagels," H. W. Schmidt, Halle-a.-S.

the various bodies present in the atmosphere. The possibility of contact electricity between a solid or liquid and a gas, is not quite easy to submit to the test of experiment. If we rub two solid bodies together, we may, by separating them, investigate the electric field produced; but, supposing we have a drop of water surrounded on all sides by air, the water may be covered with an electric layer of, say, positive electricity, the air in contact with the water with the opposite kind, and it is not at all clear how we could experimentally demonstrate the difference of potential between the air and the drop which is thus produced. A current of air flowing past the drop might carry away some of the negative layer, and in this way an electric field may be established while clouds are forming, but the conditions necessary for an experimental demonstration would be very difficulty to realise. Two methods have been devised which practically demonstrate some form of contact electricity between gases and water.

Lenard, wishing to imitate the electric field observed in the neighbourhood of waterfalls, has established by careful experiment a number of important facts, which are all consistent with the following explanation. If we imagine two oppositely electrified layers at the surface of a drop of water such as has been referred to, and if the drop falls on to a layer of the same liquid, or if similar drops impinge on each other, the difference of potential produced by the fusion of the surface layers becomes greater than is consistent with equilibrium. For, taking the case of drops falling into a mass of water contained in a cylindrical vessel, the extent of surface between air and water is not increased by the falling drops, and we must imagine that surface to be already covered with a sufficient electrical sheet to establish the required difference of potential, The electrification of the drops is, therefore, not wanted, and a change in the distribution takes place. The natural supposition would be, that this equilibrium would be restored very quickly through the surface of the water, but a certain time seems to be required for this. Meanwhile, the strong current of air which in Lenard's experiments is brought down with the water drops carry some of the electricity away, the water remaining positive. More recent experiments of Lord Kelvin's, with air bubbling through water, point similarly to contact forces between gases and liquids, and in these experiments also it appears that a considerable time is required to establish electric equilibrium between a gas and a solid. Lenard finds very important differences caused by small impurities in the water, the water acting much more strongly when it is pure. If it contains as much salt as is contained in the sea, the effect is reversed, and the air becomes positively electrified. The explanation which is given above is practically that of Lenard, whose observations have been confirmed and further extended by Prof. J. J. Thomson. These experiments, no doubt, account for the behaviour of air in the neighbourhood of waterfalls, and they probably also explain the negative electrification of air in the neighbourhood of districts in which rain is falling. The strong positive electrification of mist may also be due to the same cause.

There seems to be no doubt that the formation of a cloud is often accompanied by electrical effects. A few years ago, descending from the Dent Blanche, I found myself, after sunset, at a height of about 12,000 feet. A current of air was apparently blowing up the valley which stretches from Evolena towards Ferpecle, and I could observe a cloud condensing below me at a height a little below the snow-line. As night came on and we continued our descent over the glacier and down the valley, a series of electric discharges were noticed between the cloud, which was lying in a deep-cut valley, the sides of the mountain, and the blue sky overhead. Here the moist air was evidently streaming through the cloud, depositing its moisture in the form of drops, and it seemed the most natural explanation at the time that the air left the cloud in an electrified state.

But while by means of experiments we have been able to produce some of the phenomena of atmospheric electricity, we have other important effects which cannot be accounted for in so simple a way. The electric discharges during a thunderstorm give evidence of electric fields, which could hardly be explained by contact electricity between drops of water and air alone. The fact that thunderstorms are nearly always connected with the formation of hail, and Faraday's experiments showing that water rubbing against ice becomes negatively electrified, is made use of in the theories of Sohnke and Luvini. It is quite likely that there is some truth in these theories. Their weak point lies in the difficulty of seeing how particles of ice and water can be first sufficiently mixed to allow of friction, and then become sufficiently separated to produce an electric field of such magnitude as we know must exist in a thunder cloud.

It is to be remarked, however, that the laws of contact electricity must be applicable to gases as well as to solids, and that if water becomes positive when rubbing against air, and negative when rubbing against ice, there must be a strong contact difference between ice and air. In other words, it does not matter whether there is direct friction between ice and water, or whether the air forms an intermediate body. We may imagine air rising through a cloud containing drops of water negatively electrified, and then passing through an ice cloud having its negative electricity increased, thus leaving the ice and water particles at a difference of potential which may, by a fusion of the drops, increase sufficiently to produce a lightning discharge. This seems to me the most plausible theory which, in the present state of our knowledge, can be formed. As regards the permanent negative charge of the earth's surface, the time has not yet arrived for forming a definite opinion. Although we know that the earth, once electrified, would gradually lose its charge into the atmosphere, yet we can express no opinion as to the rate at which the loss is going on. That loss may be exceedingly slow, and consequently equilibrium might be attained by a very small preponderance of negative electricity brought back to its surface through some cause or other. Rain, as has already been mentioned, is more frequently electrified negatively than positively in our own climate, and though we do not know how far this holds in the tropical belt, it is at any rate possible that the surface of the earth may in this way alone make up for the loss. We may also reasonably think that Lenard's observation on salt water may account for the permanent charge. Every wave that breaks into spray under the action of a strong wind would leave the water negatively electrified, the air carrying away the positive charge. It would be of great interest to possess observations on atmospheric electricity on board ship while waves are breaking in the neighbourhood. So far we have only Exner's observations to guide us, who found, while observing at Lavinia, in Ceylon, that the spray from breaking waves affected the indications of the electrometer, proving its positive electrification (*Wiener Akad. Sitzungsberichte*, vol. xcviii.).

But although the loss of electricity from the earth's surface may be very slow, it is equally possible that it is considerable. We shall not be able to treat this question satisfactorily until we have some clearer notion of the causes of the aurora. We know that the aurora implies electric currents, and the circuit of these currents may lie completely within the earth's atmosphere, and have nothing to do with the observed fall of potential near the ground. It is also possible that the body of the earth forms part of the electric circuit, and if that is the case, there must be across different parts of the surface an outward and inward flow of positive electricity. Such a discharge could not fail to influence the phenomena we have discussed, and it seems probable that we should have some evidence derived from observation if the aurora was always accompanied by discharges through the earth's surface. Except in the polar regions, these auroræ do not seem to affect the normal fall of potential. There is a third view we may take as to the circulation of electric currents indicated by the aurora: the return current may take place in space outside the earth's atmosphere. A good deal might be said in favour of this view, and the rotation of the earth's magnetic field in space might be a sufficient cause for the production of these currents; but this is not the place to enter further into this question.

Calculations made from observation on the height of the aurora have generally resulted in an altitude of from 100 to 200 miles, except in the polar regions, where the aurora seems occasionally to descend to a much lower level. It has also been noticed that auroræ are associated with certain bands of cirrus clouds, and this seems to indicate that although the luminous phenomenon is sufficiently intense to be observed at only great heights, yet the electric phenomena may descend to the level of the cirrus.

As regards the connection between the aurora and the sun-spot period, further observations in the polar regions are needed. On the one hand, we have Paulsen's[1] statement, derived from observations in Greenland, to the effect that the greatest number

1 Paulsen, "Danske Videnskab. Selskabs Forhand.," 1889. (I have not seen the original memoir, but only an abstract in the *Jahrbuch der Astronomie und Geophysik*, 1890.)

of auroræ are seen when sun-spots are at their minimum, that is, at a time when in our own latitudes the number is smallest; and, on the other hand, we have Nordenskiöld's observations, which seem to point in the opposite direction. In a publication which contains much important matter on the geographical distribution and form of the aurora borealis, Nordenskiöld contrasts the appearances he has observed in the *Vega* during the winter of 1878–79, passed in the Behring Straits, with that previously observed in 1872–73 to the north of Spitzbergen. According to this author, the auroræ, during the minimum sun-spot period in 1878–79, were "hardly worthy of his notice by the side of those observed in 1872–73." But although only faintly luminous, the auroræ of 1879 were persistent and regular in shape. They did not affect the magnetic field, and seem to show a regular and continuous, though weak, electric discharge. The arc and streamers in 1872 were much more brilliant and much more irregular. Some objection may be raised against these observations, in so far as they refer to different places, and local circumstances may have affected the phenomenon; but in the face of the very careful description he gives us, we cannot as yet accept Paulsen's results without further confirmation.

The problem of atmospheric electricity, like that of terrestrial magnetism, presents special features in the arctic regions, and until we possess a greater number of observations in those little accessible parts of the earth's surface, many important problems cannot be satisfactorily solved. Arctic and antarctic expeditions are of interest to scientific men, not because they care much whether we get a few miles nearer the pole, but because a well-conducted party collects invaluable information on its journey. Although much remains to be done in the regions surrounding the north magnetic pole, our knowledge in the southern hemisphere is almost disgracefully inadequate, and it is to be hoped that before long a well-equipped expedition may fill up to a certain extent the large gaps in our electrical and magnetical knowledge which at present stop so many of our researches.

But although investigations to be conducted in the arctic regions are of primary importance, we may do much nearer home in extending and completing existing information. Instrumental appliances and methods of observation, originally put into a satisfactory state by Lord Kelvin, have been improved, especially by Mascart, Exner, Elster, and Geitel. One of our most crying wants at present is a series of continuous observations by means of self-registering instruments in places where the neighbourhood of a town, or other local circumstances, do not interfere with the normal changes. The Greenwich Observatory, to which we look for help in such matters, is placed in the difficulty that the daily variations there observed are markedly different from those in the majority of places, and it is probable that the nearness of London is fatal to any generally useful series of observations of atmospheric electricity being conducted in our national Observatory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual general meeting of the Association of Technical Institutions will be held at the Goldsmiths' Hall on Friday, the 24th inst.

THE Senate of University College, Liverpool, on the joint recommendation of Profs. Lodge and Hele Shaw, have appointed Mr. Alfred Hay, B.Sc., of University College, Nottingham, to the Lectureship on Electrotechnics, vacant by reason of the election of Mr. F. G. Baily to the chair of Electrical Engineering at the Heriot-Watt College, Edinburgh.

MR. L. F. GOLDSTAND has presented the Royal Agricultural College, Cirencester, with the sum of £200 for the institution of three silver medals annually, to be awarded according to results of the final examination for the diploma, at the discretion and decision of the Principal. The donor has requested that the medals be styled the "McClellan," the "Harker," and the "Goldstand," respectively; and the Principal, on behalf of the Governing Body, has accepted and ratified the donation.

THE eighth annual report, just published by the National Association for the Promotion of Technical and Secondary Education, is a mine of statistical and other information referring to the development of educational organisation in Great Britain. Substantial progress is recorded in the work of technical education; and it appears that of the £744,000 annually available in England alone, £600,000 is being spent on education. In the year covered by the report, 7252 scholarships and exhibitions, of the total yearly value of £40,598, were offered by thirty-seven counties. A large section of the report is devoted to summarising the recommendations of the Royal Commission on Secondary Education.

AMONG recent appointments and nominations abroad, we notice the following:—Dr. Hürthle to be Extraordinary Professor of Physiology at Breslau; Dr. N. Busch to be Director of the Botanic Garden of the University of Dorpat; Dr. K. G. Huefner, Professor of Organic and Physiological Chemistry at Tübingen, to succeed the late Prof. Hoppe-Seyler at Strassburg; Dr. Bauschinger, of Munich, to succeed the late Prof. Tietjen as Extraordinary Professor of Astronomy at Berlin; Dr. Anton F. v. Eiselsberg, Professor of Surgery at Utrecht, to be Prof. Braun's successor at Königsberg; Dr. H. Nichols to be Lecturer in Psychology in the Johns Hopkins University, Baltimore.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for August 1895 contains: On the variation of *Haliclystus octoradiatus*, by Edward T. Brown (plate 1). Some 154 specimens were examined, 120 of these were perfectly normal but 34 afforded either cases of congenital variation, or showed regeneration of organs after destruction or injury. Most of the abnormal forms are figured.—On the collar-cells of Heterocœla, by George Bidder (plate 2). Observations were made on *Leucandra aspera*, *Sycon raphanus*, *S. compressum*; this last was found best suited for examination under high powers during life, its collar-cells are among the largest, if not as large, as any known. The protoplasm of these cells is in life greenish, and they have nearly the form and relation to each other of full corn-sacks standing side by side in a granary. The living collar is invariably an almost perfect cylinder, very little constricted at its base. As to Sollas's membrane, the statements of Vosmaer and Pekelharing, which the author once thought erroneous, he now confirms, there is no normal union of the collars, the membrane is only to be met with in "paraffin sections."—The metamorphosis of Echinoderms, by Henry Bury (plates 3–9). With the view of clearing up some of the differences in observation and opinion of the more recent observers of the metamorphosis of this group, the author has worked out as far as possible the metamorphic changes of at least one form of larva in each of the five classes of Echinoderms; for reasons given, the metamorphosis of Synapta is written in greater detail than that of the rest. As to the relation of the Echinodermata to the Enteropneusta, "there seems to be a chain of evidence of their connection, which though not indeed conclusive—that embryological evidence alone can never be—is at least as strong as that which binds together any two of the great subdivisions of the animal kingdom."—A criticism of the cell-theory; being an answer to Mr. Sedgwick's article on the inadequacy of the cellular theory of development, by Gilbert C. Bourne. The article of Prof. Sedgwick here criticised appeared in the *Q.J.M.S.* for November 1894.

The number for November 1895 contains:—On the distribution of assimilated iron compounds, other than Hæmoglobin and Hæmatins, in animal and vegetable cells, by Dr. A. B. Macallum (plates 10–12). After some preliminary remarks on the special literature of the subject and references thereto, the author details his methods of study. This portion of the memoir is very instructive, not only for the facts recorded, but for the hints given; chlorophyll yields no evidence that it contains iron, and it is mentioned incidentally that species of Monotropa remain colourless when fixed in solutions of corrosive sublimate. The greater part and sometimes the whole of the assimilated iron in the cells of the higher forms of animal life is held in the nucleus, in the chromatin of which it is chiefly found, and the same is true of the nuclei of all the higher vegetable organisms; it is rarely found in the cytoplasm of the cells, but full details of such occurrences are given. An important section is devoted to the occurrence of assimilated iron in special forms of life, such as in protozoa, fungi, bacteria, and the Cyanophyceæ.—On the structural changes in the reproductive cells during the spermatogenesis of Elasmobranchs, by J. E. S. Moore (plates 13–16). The author establishes a long series of structural homologies found before, during, and after the synaptic phase in the repro-

ductive cycles of both animals and plants, and so close is their correspondence, amid a host of complex structural details, that it is in the highest degree improbable that the two series of phenomena can have been independently evolved; and whatever the synapsis may eventually turn out to be, it is evidently a cellular metamorphosis of a profoundly fundamental character, which would appear to have been acquired before the animal and vegetable ancestry went apart, and to have existed ever since.—Notes on the fecundation of the egg of *Sphærechinus granularis*, and on the maturation and fertilisation of the egg of *Phallusia mammillata*, by M. D. Hill (plate 17). In these forms there is no egg astrosphere or egg centrosome; both these structures are brought into the ovum by the spermatozoon, and they give rise by division to all the subsequent astrospheres and centrosomes throughout ontogeny. There is consequently no such thing as a "quadrille."—Further remarks on the cell-theory, with a reply to Mr. Bourne, by Adam Sedgwick, F.R.S.

Symons's Monthly Magazine for December contains a climatological table and summary for various selected stations of the British Empire, for the year 1894. Australia records the highest shade temperature, viz. 107°·0 at Adelaide, on November 26, and it was the dryest station. In the twelve years for which the annual summaries have appeared, this station has yielded the highest maximum in ten years, Melbourne in one, and Calcutta in one. The lowest temperature in the shade was recorded at Winnipeg, -46°·1 on January 24. This station has never been equalled for lowness of absolute shade temperature, and has only twice failed to record the greatest mean daily range; the variation during the year amounted to 141°·9. The dampest station was Esquimalt, where the mean humidity was 88 per cent.; London comes next, being 81 per cent., and both these places were the most cloudy, the average amount being 6·3. The least cloudy stations were Bombay and Grenada, where the average amount was 4·0. The greatest annual rainfall, 77·5 inches, occurred at Colombo, and the least, 18·1 inches, at Winnipeg. The Cape of Good Hope observations were unfortunately missing.

L'Anthropologie, 1895, Tome vi. No. 4.—Quatenary deer of Bagnères-de-Bigorre (Hautes-Pyrénées), by Édouard Harlé.—A careful examination of the mandible has led the author to the conclusion that the animal to which it belonged was neither a reindeer nor a stag, but that it must be considered a variety of the fallow-deer; and its presence in conjunction with *Elephas primigenius*, *Rhinoceros tichorinus*, and the reindeer, at the foot of the Pyrenees, is a fact of some interest.—Note on the age of metals in the Ukraine, by Baron de Baye. The progress of civilisation was not uniform in the north and south of Russia in Europe. In the district south of a line which corresponds very closely with the 50th parallel of latitude, it has been found that the use of metals was known at a very early date, whilst the Stone Age continued for a much longer period in countries to the north of this line. Baron de Baye is careful to explain that the term "Scythian," which he uses freely in connection with the mounds and the various bronze articles found in them, does not express an anthropological unit, but is used in a purely geographical and ethnological sense. The numerous tribes, however, comprehended under this name had the same civilisation, practised the same arts and the same funeral rites, and left behind them similar archæological remains.—Anthropological observations on the tumuli and worked flints of the Somali and the Danakil, by Dr. Jousseaume. The tombs are constructed of rough stones, more or less spherical or ovoid in shape, and of various sizes. The flints are arranged by the author in four groups, the first of which is represented by a single specimen in the form of a wedge. The second group is spatulate, rather long, very thick, and always larger at one end than at the other. The flints included in the third group are discoidal, and of various sizes; while the fourth group includes all those that are lance-shaped.—Infantilism, feminism, and the hermaphrodites of the ancients, by Henry Meïge. In this section of his paper the author treats of feminism, of which a very beautiful example came under the observation of Prof. Charcot at La Salpêtrière.

Bollettino della Società Sismologica Italiana, vol. i., 1895, No. 6.—Earthquake of Paramythia (Epirus) during the night of May 13-14, 1895, by G. Agamennone (see p. 205).—The Guzzanti microseismoscope, by G. Guzzanti.—Notices of Italian earthquakes (April–May 1895), referring chiefly to the Florentine earthquake of May 18, and to the pulsations of the earthquake of Paramythia of May 13-14.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 28, 1895.—"The Expansion of Argon and of Helium as compared with that of Air and Hydrogen." By Dr. J. P. Kuenen, Professor of Physics in University College, Dundee, and Dr. W. W. Randall, Lecturer in John Hopkins University, Baltimore, U.S.A.

The gas-thermometer used for these experiments was such as could be easily heated by means of a "Ramsay and Young" vapour-jacket. It consisted of a bulb sealed on to a capillary tube, which in turn was sealed on to a wider tube, provided with a mark. This mark is situated just outside the heating arrangement, immediately below the capillary tube. The inner mercury-surface is made to coincide with this mark, and both this one and the outer surface are read on a scale with a telescope. The readings were duly corrected for capillary action, expansion of glass and mercury, and the part of the gas that is not heated. The results show that up to 240° C., the highest temperature that was employed, the expansion of both argon and helium is very nearly the same as that of air and hydrogen.

December 5, 1895.—"Studies in the Morphology of Spore-producing Members. Part II. Ophioglossaceæ." By F. O. Bower, F.R.S. Preliminary Statement on the Sorus of *Danæa*, by F. O. Bower, F.R.S.

In Part I. of these studies it had been shown on comparative grounds to be probable that septation of sporangia, previously in the race simple, had taken place among the Lycopodineæ. It appeared, however, important to show that such a process of septation has taken place elsewhere; examples of it are found in the anthers of many Angiosperms of the orders Mimoseæ, Onagraceæ, Loranthaceæ, Rhizophoreæ, &c. The development has been studied in certain cases, and it is seen that a partial sterilisation of sporogenous cells results in the formation of sterile septa, which may vary greatly in thickness from a broad band of tissue to a narrow one; sometimes the septum may be represented by a single layer of cells of the nature of a tapetum, or the septum may be incomplete. A comparison of these cases with plants of Pteridophytic affinity shows that similar structural and developmental details are found: the most conspicuous case is that of *Danæa*, in which large synangia are found on the under-surface of the leaf; these, though attached along the leaf surface, have a structural similarity to the spike of *Ophioglossum*. It is not uncommon to find in them, as in the Angiosperms quoted, great variety of size of the loculi, and of thickness of the septa, while incomplete septa are also common: the close parallel as to these characters is a very striking feature, and raises the probability of their having resulted from a similar mode of evolutionary progress, *i.e.* by septation.

The second part of the "studies" refers to the Ophioglossaceæ, and the suggestion made by various writers (Mettenius, Strasburger, Celakovsky, and others), that they are related to the Lycopods is upheld; it is supported on grounds of comparison of external form, of anatomy, of the characters of the Gametophyte and embryology, as far as known. From these various sources a general support of the relationship has been traced, the nearest point of comparison appearing to be between *O. Bergianum*, and *Phylloglossum Drummondii*. It is contended that the external similarity of these plants, long since recognised, is not a case of mere mimicry, but of real relationship, though this probably dates from an unknown common ancestry.

Such a relationship involves the idea of septation; but it has been shown that septation of a very similar nature has taken place in the anthers of Angiosperms. *Danæa* among Pteridophytes shows very similar characters, and, finally, a minute study of development in *Ophioglossum* has elicited facts which are compatible with such a view. From simple types of *Ophioglossum* a progression may be traced to the larger and more complex species, *e.g.*, *O. palmatum*; while a somewhat parallel sequence would lead from such a plant as *Botrychium simplex* onwards to the larger, elaborate species of the genus. *Helminthostachys* appears to hold a somewhat independent position.

December 12, 1895.—"On the Formation and Structure of Dental Enamel." By J. Leon Williams, D.D.S., L.D.S.

The special points in the formation and structure of ename

which I have attempted to elucidate in this paper, may be summarised as follows:—

(1) The existence of a very thin membrane, or a structure of membrane-like appearance, lying between the ameloblasts and the forming enamel, and also between these cells and those of the stratum intermedium. I have also, in many specimens, seen a similar membrane covering the odontoblasts.

(2) The formation of enamel by deposit, and not by cell calcification. This deposit probably consists of two distinct cell products—a granular plasm and spherules of calcoglobulin.

(3) The relation of the cells of the stratum intermedium to true secreting tissue; this relation being especially marked in the enamel organs of the rat and mouse.

(4) An intricate vascular network in the stratum intermedium. I should also mention that I have seen a free distribution of blood vessels in the odontoblastic layer of cells in the mouse, rat, and calf, as well as in human embryos, thus conclusively proving that these cells are not calcified.

(5) The fibrous character of enamel in many of the lower animals, and the change of these fibres into more or less regularly arranged granules in the monkey and in man.

(6) That the varicosities of the enamel rods are not caused by acids (although often rendered more clear to view by acid treatment), but represent a true structural peculiarity of this tissue. That these varicosities, which often continue in an uninterrupted line across large fields of view, correspond with the course of one set of fibres. The varicosities may, therefore, be caused by the presence of this set of cross fibres. The only alternative explanation which has occurred to me is that there may be a rhythmic, simultaneous action of all the ameloblasts concerned in the deposit of the material for enamel building. The last theory seems to be less reasonable than the first.[1]

(7) The Retzius bands are often as distinctly marked in forming as in mature teeth, and in teeth which have been kept constantly moist, as they are in dried specimens. The enamel rods are often seen to pass without break across several of these bands. The bands are principally due to a deposit of pigment, and not to imprisoned air or gas, as claimed by von Ebner.

Chemical Society, December, 5, 1895.—Mr. A. Vernon Harcourt, President, in the chair.—The following papers were read:—Researches on the terpenes, VI. Products of the oxidation of camphene; camphoic acid and its derivatives, by J. E. Marsh and J. A. Gardner. Camphoic acid, $C_{10}H_{14}O_6$, is the chief oxidation product of camphene; a number of new derivatives of the camphopyric acids, $C_9H_{14}O_4$, are described.—New derivatives from α-dibromocamphor, by M. O. Forster. On treating α-dibromocamphor with nitric acid, a lactone, dibromocampholidid, $C_{10}H_{14}Br_2O_2$, is obtained; on reduction it yields an unsaturated acid, bromocamphorenic acid, $C_{10}H_{15}BrO_2$. Camphorenic acid, $C_{10}H_{16}O_2$, and campholidid, $C_{10}H_{16}O_2$, have been prepared.—Isomeric π-bromo-α-nitrocamphors, by A. Lapworth and F. S. Kipping. π-bromo-α-nitrocamphor is obtained, together with a bromocamphoric acid, by heating π-dibromocamphor with nitric acid; it is converted into an isomeride by crystallisation from hydrochloric acid. These two substances are probably cis- and trans-isomerides.—Derivatives of π-bromocamphoric acid, by F. S. Kipping. π-bromocamphoric acid, when treated with alkalis, yields first a lactonic acid, $C_{10}H_{14}O_4$, and then π-hydroxycamphoric acid, $C_{10}H_{16}O_5$; it probably contains the group CH_2Br.—π-dibromocamphoric acid and its derivatives, by F. S. Kipping. π-dibromocamphoric anhydride, $C_{10}H_{12}Br_2O_3$, is prepared by the action of bromine and red phosphorus on π-bromocamphoric acid; it yields π-dibromocamphoric acid, $C_{10}H_{14}Br_2O_4$, when heated with nitric acid, and π-bromocamphanic acid, $C_{10}H_{13}BrO_4$ on boiling with water.—ω-bromocamphoric acid, by F.S. Kipping. ω-bromocamphoric acid, isomeric with π-bromocamphoric acid, is obtained by hydrolysing Wreden's bromocamphoric anhydride.—π-chlorocamphoric acid, by F. S. Kipping and W. J. Pope. π-chlorocamphoric acid, $C_{10}H_{15}ClO_4$, is prepared by oxidising π-dibromocamphor with nitric acid.—Derivatives of α-hydrindone, by C. Revis and F. S. Kipping. Dibromohydrindone is obtained by the action of a soda solution of bromine on α-hydrindone at ordinary temperatures, whilst at 100° a condensation product of the composition $C_{18}H_{12}O_3$ is obtained. When monobromohydrindone is dissolved in cold alcoholic potash, a condensation product of the composition $C_{18}H_{13}BrO_2$ is deposited.—The alkaline reduction of metanitraniline, by R. Meldola and E. R. Andrews. Alkaline reducing agents convert metanitraniline into an azoxy-compound,

$$\begin{matrix} NH_2.C_6H_4.N \\ NH_2.C_6H_4.N \end{matrix}\Big\rangle O;$$

the corresponding azo-compound has also been prepared.—The chemistry of dibromopropylthiocarbimide; and the action of bromine and iodine upon allylthiourea, by A. E. Dixon.

[1] Since the above was written, I have demonstrated that there is a simultaneous deposit of the spherical bodies over the entire surface of forming enamel.—J. L. W.

Linnean Society, December 5, 1895.—C. B. Clarke, F.R.S., President, in the chair.—Messrs. Bernard Arnold and Rupert Vallentin were admitted, and the following were elected Fellows of the Society: W. M. Christy, Rev. H. P. Fitzgerald, A. W. Geffeken, Rev. E. A. Peacock, Rev. T. R. Stebbing, and W. O. Stentiford.—The President called attention to a portrait of the late Prof. Babington, of Cambridge, which had been lately presented by his widow to the Society. On the motion of Dr. Murie, seconded by Mr. A. W. Bennett, a vote of thanks to Mrs. Babington was unanimously accorded.—Prof. Stewart offered some remarks on the types of the axes of certain Gorgonaceæ, in which he referred chiefly to the importance or otherwise of the presence of spicules in the axes, and exhibited the following species in illustration of his remarks: *Paragorgia arborea*, *Melitodes ochracea*, *Suberogorgia suberosa*, *Corallium rubrum*, *Caligorgia verticillata*, *Verrucella guadalupensis*, *Isis hippuris*, *Plexaurella crassa*, and *Eunicella verrucosa*. Some criticism was offered by Dr. Murie, chiefly in relation to the structure of *Gorgonia flabellum* and *Gorgonia setosa*.—Mr. Martin Woodward exhibited and made remarks on a living specimen of *Ouramœba*, which he thought should be regarded as a common Amœba attacked by a parasitic fungus.—Mr. G. C. Druce communicated a paper on a new species of *Bromus* in Britain, which was said to differ from others of the genus in its inflorescence, having single, short, stiff pedicels arising alternately right and left of the main rachis, each bearing at its extremity 3-5 sessile, or in some cases shortly stalked spikelets, giving an interrupted and compact appearance to the whole inflorescence, which is made up of two rows of clustered groups of 3-5 spikelets. This peculiar feature being absent in its nearest allies, the name *interruptus* was proposed to distinguish it; another feature being that the palea was split to the base, and not merely bifid. It appeared to have been described or referred to by Prof. Hackel as *Bromus mollis*, var. *interruptus*, but Mr. Druce considered that it was sufficiently distinct to be entitled to specific rank. He had found it growing abundantly in a field of vetches near Upton, Berkshire, and specimens had been examined from Headington, Oxford, and Dartford, Kent. In a discussion which followed, Dr. O. Stapf reviewed the literature of the subject, and gave reasons for regarding the so-called new species as merely an abnormal growth of *Bromus mollis*. Critical remarks were made also by Mr. H. Groves and Mr. A. B. Rendle, who were inclined to share the opinion of the last speaker.—A paper was then read by Mr. W. F. Kirby, on some new or little-known *Phasmidæ* in the collection of the British Museum, with illustrative specimens.

Mathematical Society, December 12, 1895.—Major P. A. MacMahon, R.A., F.R.S., President, in the chair.—Prof. Hill, F.R.S., gave a sketch of a note on the convergency of series, by Dr. R. Bryant.—Lieut.-Colonel Cunningham, R.E., communicated at some length a paper on the criterion of 2 as a 16^{ic} residue. A discussion followed the reading, in which Messrs. Bickmore, Kempe and the President took part.—Dr. Hobson, F.R.S., read a short note on the distribution of electricity induced on an infinite disc with a circular hole in it, by Mr. H. M. Macdonald.—A paper by Dr. R. Lachlan, on the double foci of a bicircular quartic, and the nodal focal curves of a cyclide, was taken as read.

Zoological Society, December 17, 1895.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Dr. Donaldson Smith offered some remarks on some of the animals observed by him during his recent journey to the Lakes Rudolph and Stephanie, and alluded especially to the species of zebras and antelopes encountered during his journey.—Mr. Sclater exhibited and made remarks on the head of an antelope obtained in Kavirondo, British East Africa, by Mr. E. Gedge. This antelope had been hitherto usually identified with the "kob" of Western Africa, but appeared to belong to a distinct species, to which the name *Cobus thomasi* had been given by Herr Neumann.—Mr. G. F. Hampson read a paper on the classification of two sub-families of the moths and of the family

Pyralidæ, the *Schœnobiinæ* and *Crambinæ*.—A communication was read from Mr. Oldfield Thomas, on *Cœnolestes*, a still-existing survivor of the Epanorthidæ of Ameghino, and the representative of a new family of recent Marsupials.—Mr. Walter E. Collinge read a paper on the sensory and ampullary canals of *Chimæra*, and the innervation of the same.—Mr. F. A. Bather read a paper on the fossil crinoid *Uintacrinus*. The paper attempted a complete morphological description of *Uintacrinus socialis*, based on specimens from the Upper Cretaceous Beds of Western Kansas, now in the British Museum.—A communication from Dr. C. Brunner von Wattenwyl gave a list of the Orthoptera of the Hawaiian islands.

Royal Meteorological Society, December 18, 1895.—Mr. R. Inwards, President, in the chair.—Mr. R. H. Scott, F.R.S., read a paper on some of the differences between fogs, as related to the weather systems which accompany them. In this it was shown that there are at least two distinct classes of phenomena described under the generic name of "fog." In the case of anticyclonic fogs, no rainfall takes place; the temperature is low in the morning, and there is a considerable rise of temperature during the day; while in the case of cyclonic fogs, rainfall does take place, and the temperature is high in the morning, frequently approaching or even equalling the maximum for the day. Mr. Scott also investigated the cases of several well-marked fogs in London, and found that there was no direct relation traceable between the temperature accompanying them and the death rate.—Major H. E. Rawson described the results of his analysis of the Greenwich barometrical observations from 1879 to 1890, with special reference to the declination of the sun and moon.—A paper by Mr. S. C. Knott was read, giving the results of his meteorological observations taken at Mojanga, Madagascar.—Mr. Scott also exhibited some specimens of the illustrations in the "International Cloud Atlas," which is now being prepared for publication.

PARIS.

Academy of Sciences, December 23, 1895.—Annual public meeting.—M. Marey in the chair.—The President delivered an address, in which reference was made to the celebration, in October last, of the centenary of the Institute of France. The members and associates deceased during the year—MM. Pasteur, Verneuil, Larrey, Cayley, Dana, Vogt, Ludwig, Huxley, Lovén, Hellriegel—were referred to, and a brief *résumé* given of the life-work of each. The President then announced that a biennial prize (20,000 fr.), which is in rotation in the gift of each of the five Academies, and which this year fell to the Academy of Sciences, has been awarded to M. Raoult for his discovery of the numerical relations between the molecular weight of a substance and the lowering of the freezing point and vapour pressure of its solvent. The other prizes were awarded as follows: The Francœur prize to M. J. Andrade, the Poncelet prize to M. G. Robin, for his contributions to mathematical physics. In Mechanics, the extraordinary prize of 6000 fr. was divided between M. Mottez (2500 fr.), for his work on the correction of ships' compasses; M. Houette (1500 fr.), for his aids to navigation; M. Gosselin (1500 fr.), for his method of studying the velocity of projectiles; and M. Baucher (500 fr.), for his study of the action of sea-water upon metals. The Montyon prize was given to M. Galliot, for a new application of electric traction on canals; and the Plumey prize to MM. Pollard and Dudebout. The Fourneyron prize was divided between M. G. Marié and M. Lecornu, for their experimental and theoretical work on steam governors. In astronomy, the Lalande prize fell to M. M. Hamy; and the Valz prize to Mr. Denning (of Bristol), for his work on comets and shooting stars. In Physics, M. E. Bouty was accorded the La Caze prize for his numerous researches in electricity and magnetism; in Statistics, the Montyon prize was divided between M. A. Martin and M. C. Baltet, whilst honourable mention was accorded to MM. Hovelacque and Hervé. In Chemistry, the Jecker prize was divided between M. Tanret (6000 fr.), M. Renard (2000 fr.), and M. Burcker (2000 fr.); whilst the La Caze prize was given to M. Le Chatelier for his researches on the combustion of explosive mixtures, pyrometry, and thermodynamics of chemical processes. In Mineralogy and Geology, the Grand prize for the physical sciences was adjudged to M. C. Brongniart for his researches in palæontology; the Delesse prize to M. Delafond for his stratigraphical studies; whilst the Bordin prize is equally divided between M. de Pousargues and M. Barrat. In Botany, the Desmazières prize was awarded to M. Borzi, the Montagne prize to M. F. Renauld, and the De la Fons-Mélicocq prize (900 fr.) to M. G. de la Marlière. In Anatomy and Zoology, the Thore prize fell to M. P. Mégnin, the Savigny prize being not awarded. In Medicine and Surgery, three Montyon prizes were given, to MM. Gangolphe, Imbert, and Teisser; mentions and minor awards went to MM. Chipault, Gouguenheim and Glover, Polaillon, Bellini, and Parant. The Barbier prize was divided between M. Bœckel and M. Dupuy, the Bréant prize being left unawarded. M. E. Reymond was adjudged the Godard prize, M. Lancereaux the Chaussier prize, and M. Vaillard the Bellion prize, with honourable mention to M. Vincent and M. Rouget, M. Mauclaire and M. Detroye. The Mège prize was awarded to M. Baudron, and in connection with the Dusgate prize (not given) honourable mention was accorded to M. Icard. The Lallemand prize was divided between M. Toulouse and M. Halipré, with mention of MM. Chervin and Debierre. In Physiology, the Montyon prize was given to M. Artus (with mention of M. Tissot), the La Caze prize to M. Dastre, the Pourrat prize to M. Charrin, the Philipeaux prize to M. Chabrié, the Martin-Damourette prize being divided between M. Besson and M. Cristiani, with honourable mention of Dr. de Keating Hart. In Physical Geography, the Gay prize was awarded to M. Angot, a second prize (1000 fr.) being given to a paper by an anonymous author. General prizes: The Montyon prize (unhealthy industries) was given to M. Gérardin, the Trémont prize to M. B. Renault, the Gegner prize again to M. Paul Serret, the Petit D'Ormoy prize to M. Albert Ribaucour, for the mathematical sciences, and to M. Pomel for the natural sciences. The Leconte prize was awarded to Lord Rayleigh and Prof. Ramsay for their work on the constitution of atmospheric air. The Tchihatchef prize was adjudged to Dr. Radde, the Gaston Planté prize to MM. J. and P. Curie, the Saintour prize to M. Termier. The Cahours prize was divided between MM. Lebeau, Simon, and Varet, the Alberto Levi prize (50,000 fr.) between MM. Behring and Roux; to the former for his discovery of the antidiphtheric serum, and to the latter for the happy application which he has made in France of this discovery. The Kastner-Boursault prize was awarded to M. Baudot for his improvements in multiplex telegraphy, the Laplace prize to M. Bachellery, and the Felix Rivot prize to MM. Bachellery, de Ruffi de Pontevès Gevaudan, Delemer, and Labordère. Details of the prizes announced for 1896, 1897, 1898, and 1899 are given.

BERLIN.

Meteorological Society, November 5, 1895.—Prof. Hellmann, President, in the chair.—Dr. Zenker gave an abstract of a lengthy paper on the thermal constitution of climates. He explained how, from the solar radiation which he had previously calculated out for the outer boundary of the atmosphere, he had deduced that which takes place at the inner; and how from the latter, taking into account the radiation from the earth, and the existence of clouds, he had determined the annual and monthly temperatures for areas of each two degrees of the earth's surface. In part two of his paper, he had compared the temperatures calculated as above with those actually recorded for many places in India, Africa, America, and Australia.—Mr. Archenhold exhibited the negative of a photograph of a lightning-flash taken on August 24 last. The negative showed one narrow black flash on the dark field of the heavens above the brightly illuminated tree-tops, and a second much broader, bright flash, which was brighter than the tree-tops. The opinion was expressed that probably the great intensity of the possibly multiple flash may have led to the solarisation of its own image.

Physiological Society, November 8, 1895.—Prof. du Bois Reymond, President, in the chair.—Dr. Hausemann spoke on the large interstitial cells of the testis. He had found that they occur somewhat rarely in the connective tissue between the tubules in hibernators during their winter sleep, but are, on the other hand, extremely numerous after they awake. In man they are plentiful in the newly-born and children, less numerous at puberty and during manhood, and increase again largely in numbers in old-age.—Dr. Rawitz had repeated Loeb's experiments on the normal development of exovates, and the remains of impregnated sea-urchin's eggs after treatment with dilute sea-water. In most cases the exovates succumbed as well as the eggs; in only one case had he observed that while the exovate succumbed, the

egg developed into a complete gastrula. From this it appeared that the exit of a portion of the contents of the egg had no influence on the development of the remaining part.—Prof. Zuntz criticised a recent paper by Filehne and Kiouka, in which they attempted to disprove his view that the increased respiratory frequency during muscular exertion is due to the action on the respiratory centre of some product formed during the activity of the muscles. He showed that their objections do not hold good, and that their experiments do not upset his conclusions.

November 29, 1895.—Prof. du Bois Reymond, President, in the chair.—Dr. René du Bois Reymond spoke on the opposition of the thumb, a point on which very scanty and insufficient information is contained in text-books of anatomy. He had studied in detail the theory of saddle-joints, and on the assumption that the movements take place about two axes at right angles to each other and passing through the point of contact of the two bones, he had arrived by construction at a mathematical formula corresponding to the ideal saddle-joint. This formula shows that a certain very limited amount of rotation is possible in this joint. He had further investigated, by the horopter and photographically, the actual movements of the thumb, the hand being firmly fixed, and gave the several phases of the movements which occur in the joint between the metacarpus and trapezium, and between the phalanx and the metacarpus during opposition.—Dr. Schultz demonstrated on the humerus of a duck the connection between the lungs and the bone cavities.

Physical Society, November 15, 1895.—Prof. von Bezold, President, in the chair.—Prof. Warburg gave a short account of experiments, by W. J. Wäggener, on the temperature of the flame of a Bunsen burner. The measurements were made with carefully-tested Le Chatellier's thermo-electric elements. The accuracy of the measurements was further tested in two directions. Firstly, with reference to the effect of high temperature on the E.M.F. of the element, it was found that prolonged heating makes the platino-iridium wire more markedly irregular than it does the platinum; hence the element was exposed to the flame for a short time only. Secondly, with reference to the disturbing effect of heat conduction, it was found with wires of 0·5, 0·2, 0·1 and 0·05 mm. diameter, that when they are coiled up so that they can be almost completely enveloped in the zone of active combustion the three thicker wires recorded the same temperature, whereas, when not so coiled up, the thicker wires gave a lower temperature. The thinnest wire gave the highest values in the outer edge of the flame and in the zone of active combustion, in the inner cone a lower value than that given by the wire of 0·1 mm. The highest temperature recorded was 1704° C. Taking the highest records of the above four wires, and representing them graphically, a curve was obtained which gave the value 1750° C. for a wire of zero thickness, a temperature not much below the melting point of platinum, 1780° C.—Prof. Thiesen spoke on the formulæ which make it possible to obtain a perfect image with a simple lens.

AMSTERDAM.

Royal Academy of Sciences, October 26, 1895.—Prof. Van Sande Bakhuyzen in the chair.—Prof. Martin read a paper on Tertiary fossils from the Philippines. Basing his arguments upon a collection of fossils formed many years ago by Semper in the Philippines, the author showed that in Luzon, in the upper course of the Rio Grande de Cagayan, there appear neo-miocene strata, which must be considered equivalent to the typical neo-miocene of Java. Similar strata are also found in Cebú; moreover, neo-tertiary (miocene or pliocene?) fossils have been brought away by Semper from the hills of Aringay in Luzón, and finally pliocene ones from the Rio Agusan, Mindanáo. In the Philippines there occur tertiary and newer deposits, which correspond to the newer sediments in Java, both as regards the age and the petrographic structure and the fossil fauna of the said strata.—Mr. Jan de Vries presented a paper on a class of complete functions. Let W be a function of γ of the nth degree, then the general formula is determined for a function that satisfies the equation $W_n - \gamma W_{n-1} + W_{n-2} = 0$.—Prof. Kamerlingh Onnes communicated Dr. Zeeman's measurements on absorption of electrical vibrations in electrolytes, undertaken at the suggestion of Prof. Cohn of Strassburg, and carried out in the Leyden laboratory. The (as yet) preliminary results are: (1) the energy of the electric vibrations in pervading an electrolyte diminishes in the logarithmic ratio; (2) if the wave-length is 6·5 m., the energy has decreased to one-third of its original value when the wave has passed through 6·5 c.m. of a solution of common salt, the resistance of which is $3200 \cdot 10^{-10}$ that of mercury.—Prof. Lorentz presented, on behalf of Mr. A. Smits, a paper, entitled "A Description of the Micromanometer." By means of the instrument described, a difference of pressure equal to $\frac{1}{1500}$ m.m. of water or $\frac{1}{20250}$ m.m. of mercury, may, if all precautions possible are taken, be measured under the most favourable conditions.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Gesammelte Abhandlungen über Entwickelungsmechanik der Organismen: Prof. W. Roux, Erster and Zweiter Bands (Leipzig, Engelmann).—Die Mikroskopische Thierwelt des Süsswassers: Dr. F. Blochmann. Abthg. 1. Protozoa (Hamburg, Gräfe).—Fauna der Gaskohle und der Kalksteine der Permformation Böhmens: Dr. A. Fritsch, Dritter Band (Prag, Rivnác).—Die Haustiere und Ihre Beziehungen zur Wirtschaft des Menschen: E. Hahn (Leipzig, Duncker).—The Story of the Solar System: G. F. Chambers (Newnes).—A Manual of Inorganic Chemistry: Dr. T. E. Thorpe, 2 Vols., new edition (Collins).—Die Spectralanalyse: Dr. J. Landauer (Braunschweig, Vieweg).—In Haunts of Wild Game: F. V. Kirby (Blackwood).—Dynamo-Electric Machinery: Prof. S. P. Thompson, 5th edition (Spon).

PAMPHLETS.—Dynamo Attendants and their Dynamos: A. H. Gibbings, 2nd edition (Rentell).—Submarine Telegraphy, &c.: J. Bell and S. Wilson (*Electricity* Office).—Pharmaceutical Society Museum Report for the Year 1893-4 (Bloomsbury Square).

SERIALS.—Proceedings of the Society for Psychical Research, December (Paul).—Popular Science Monthly, December (Paul).—American Naturalist, December (Philadelphia).—History of Mankind: F. Ratzel, Part 4 (Macmillan).—Bulletin of the Illinois State Laboratory of Natural History, Urbana, Ill., Vol. 4 (Springfield, Ill.).—Good Words, January (Isbister).—Sunday Magazine, January (Isbister).—English Illustrated Magazine, January (198 Strand).—Longman's Magazine, January (Longmans).—Economic Journal, December (Macmillan).—Astrophysical Journal, December (Wesley).—Contemporary Review, January (Isbister).—Century Magazine, January (Macmillan).—Natural Science, January (Rait).—Journal of the Chemical Society, December (Gurney).—Zeitschrift für Physikalische Chemie, xviii. Band, 4 Heft (Leipzig, Engelmann).—Fortnightly Review. January (Chapman).—The Humanitarian, January (Hutchinson).—Phonographic Quarterly Review, January (Pitman).—Journal of the Royal Microscopical Society, December (Williams).

CONTENTS.

THURSDAY, JANUARY 9, 1896.

FOOD AND ITS FUNCTIONS.

Food and its Functions: a Text-book for Students of Cookery. By James Knight, M.A., B.Sc., F.C.S., F.G.S., &c. Pp. viii + 282. (London: Blackie and Son, Ltd., 1895.)

AS a scientific work bearing upon the culinary art, "Food and its Functions," from the pen of Mr. James Knight, of Glasgow, must form a welcome addition to that branch of literature. The work is described as "a text-book for students of cookery," and the author further explains in his preface that it is an expansion of a course of lectures on dietetics, which he was privileged to deliver to the students in training at the Glasgow Schools of Cookery, and that it aims at supplying such students with a complete manual of the theoretical part of their curriculum. Of the scientific soundness and great value of this book to a considerable section of the educated classes there can be no question, but when we consider its merits as a text-book for students of cookery, we are forced to inquire what sort of students? If for such as desire to become teachers of practical cooking, and have therefore to acquire a certain amount of knowledge of the chemistry of the art and the values of foods from a scientific standpoint, then much of Mr. Knight's information and careful reasoning will certainly be useful. Still more valuable should the book be to the nursing sisterhood of the United Kingdom; and to many medical practitioners also, who have to prescribe food as well as medicine for the sick, and might perhaps be a little more closely acquainted with that part of their responsibilities. But to the ordinary learner of the business of a cook, who wants to practise rather than to preach or advise, we much fear that "Food and its Functions" cannot but be too abstruse and overladen with dry scientific details. The theoretical instruction of cookery classes, the students of which are merely seeking to become proficient workwomen, cannot, we think, speaking from experience, be too carefully pruned down, and put into words that can easily be "understanded of the people." A few simple chemical facts in regard to the different culinary processes, a few touching food-stuffs, with a judiciously condensed explanation of the dietary value of the latter, are very desirable, and may be inculcated with some degree of hopefulness. But if the rubicon of moderation be crossed, the teacher's effort is but lost labour. Not one in fifty can really follow or remember it, and the lesson falls verily upon stony ground. For this cause we are constrained to hold in question the advisability of over-instructing the instructors. A little knowledge is a dangerous thing, as we all know, and it is, moreover, a fruitful source of vanity. When the holder of a brand-new diploma—crammed with fine words—proceeds to teach, what a temptation there must be to let some of them loose, especially before an audience unable to detect inaccuracies! But when he or she, veneered with a little anatomical smattering by the aid of Mr. Knight's text-book, proceeds to chalk out on the blackboard diagrams of the alimentary canal, the stomach, the contents of the chest and abdomen, the thoracic duct and lymphatic vessels, with a few words concerning "Bernard's theory of Glycogenesis," and Pavy's view of the same, how learned the board-school-girls, or evening continuation class (who, between ourselves, want to know how to make "toad-in-the-hole") will think her, and how frightened they will be at her awful disclosures as to the secrets of their interior economies! But to be serious, while granting to the full the undoubted importance of Mr. Knight's section on the physiology of digestion to the purely theoretical student, and its value in the hands of the trained nurse, who ought, be it added, to be equally well trained in sick cookery, we cannot admit that it is necessary, or indeed advisable, for ordinary cookery classes; neither can we agree with him when he says that "it is impossible to secure the rational treatment of food without at least a slight acquaintance with" its "subsequent course within the body itself."

Having thus endeavoured to indicate the classes of readers who ought to benefit by Mr. Knight's three scientific sections, and the class for whom we consider them inapplicable, save in so far as a few simple facts to be found in the first two are concerned, we return with no little satisfaction to "parts iv. and v.," in which a goodly store of information is to be found, which ought to be appreciated not only by mere students of cookery, but by every one interested in the question of diet in relation to health, and the still more difficult one of foods best adapted to persons suffering from various forms of illness. In the former section, "Foods in detail," we find explanatory notes as to the chemical properties and dietetic value of dairy produce, eggs, animal food, fish, cereals, legumes, root-vegetables, green-stuff, fungi, fruits, accessories and condiments, beverages, alcoholic drinks, wines, ale and cider, with aërated and mineral waters. The culinary methods which are best suited to many of these, in view to their preparation for food, are adverted to, and the important question of the digestibility of each not lost sight of. The first three lessons in part v., "Dietetics," are of general interest, and ought to be studied by every housewife, for in them will be found the advice, already alluded to, touching dietary scales, diet in relation to infancy, adolescence and age, and referring to food in times of sickness, with special models to meet the cases of standard complaints.

In his last lesson regarding cookery methods, the author certainly betrays a want of practical knowledge. But this, in consideration of the excellence of his scientific instruction, may perhaps be excused. He treats of roasting and boiling with accuracy, but he is hardly correct in advocating broiling by gas *below* the flame in supersession of the time-honoured practice *over* glowing coals. "The value of the grill," says Sir Henry Thompson in allusion to that method, "is nowhere better understood than in England," and we certainly doubt whether any other way of treating a chop or steak will be accepted in the City of London, so celebrated for its grill-rooms. We do not mean to say that meat may not be done in the manner indicated by Mr. Knight, but we maintain that it can never "taste of the fire," to borrow a well-known phrase, as a chop does when well broiled over a clear fire. Nor do we concur with him, Count Rumford's dictum notwithstanding, regarding oven-roasting. Even if every trace of the oven taint be absent, no piece of

meat can be properly and constantly basted by this process, which means that it cannot possess the best qualities produced by proper roasting. The *rôtisseur*, whom Brillat Savarin considered to be like the poet "born not made," was skilful with the spit, and certainly no oven-roasted bird can approach one cooked in that manner. Mr. Knight becomes confused in regard to the frying processes. To dry-fry, the French word *sauter* is alone applicable; to wet-fry, the term is *frire*. By the former, the thing fried is supposed to be tossed or "made to leap," hence *sauter;* by the latter, it is boiled in seething fat or oil—not in a *sauté*-pan, which is too shallow, but in a *friture*-pan or frying-kettle. Clarified beef suet or prime fat is superior to oil for many things; it does not heat so rapidly, nor does it boil over as the latter is prone to do. The object of stewing is not to extract all the nutritive juices of food. On the contrary, in all the best examples of the process, those juices are sealed up to begin with as much as possible, by blanching in the case of white meat, or dry frying (the *faire revenir* of French cookery) in that of brown. After blanching, white meat is refreshed, and then laid on a couch of vegetables covered with broth and very gently stewed; while after having been seized, brown meat is moistened with warm broth just brought to the boil once, and then simmered gently till done. Of braising there are several processes, white meat being done in one way, brown in another. The *faire revenir* process is carried out in regard to the latter, and this is now also done in the case of *bœuf à la mode*—"mettez-la," says Dubois, "dans une braisière ou casserole longue avec du lard fondu; faites-la revenir sur un feu modéré jusqu'à ce qu'elle soit bien saisie et colorée: mouillez alors la viande." Lastly, with reference to soups, we should call a perfect *consommé* the finest rather than the "richest" form of soup; the latter term would be better applied to bisques, thick turtle, and all to which eggs, butter and cream are added. These few slips however are, as we have said, excusable on the part of an author who has given so much valuable information in the major portion of his work. In recommending it to all educated readers who are interested in the subject, we would say to those who may desire to use it in their instruction of the illiterate—do not lose sight of the fact that over-elaboration of the scientific and theoretical aspect of cookery may tend to the somewhat perfunctory teaching of its practical side. For this reason, as far as teaching in board-schools and evening continuation classes is concerned, let sound practical instruction be the main point, with just sufficient of theoretical teaching to explain the scientific reasons which render this, that, and the other step necessary in the different methods of cooking, and why various food-stuffs differ in nourishing value.

THE STUDY OF FUNGI.

Introduction to the Study of Fungi, their Organography, Classification, and Distribution; for the use of Collectors. By M. C. Cooke, M.A., LL.D., A.L.S. Pp. iv.+360. (London: Adam and Charles Black, 1895.)

AS a terminal group, the Fungi possess but little interest for those whose aim is to gain an insight into the general scheme of evolution of the plant-world. On the other hand, it may safely be asserted, without fear of contradiction, that no group of plants has better repaid the investigations of the specialist, as illustrated by the brilliant discoveries of De Bary, Brefeld, Ward, and others. The important part played by parasitic fungi in connection with numerous plant and animal diseases has of late years also attracted considerable attention, and with the exception of Great Britain, almost every civilised country in the world has one or more institutions specially devoted to the investigation of this branch of the subject. Another branch of the study deals with the classification or systematic arrangement of fungi, the importance of which can only be realised when it is known that above forty thousand described species have to be dealt with in such a manner that their specific individuality, affinities, location in the scheme of classification, and distribution, may be easily accessible to workers in other branches of the study. In the work under consideration, the author has given the amount of morphological information he considers necessary for the systematist to possess, at the same time indicating the additions to our knowledge resulting from the investigation of the life-history of individual species; but it is in the sections devoted to classification and distribution that Dr. Cooke appears at his best, and here we find embodied the matured experience gained during the author's connection with Kew, where he had charge of the unrivalled collection of fungi, with its thousands of type specimens, in addition to the opportunities of examining numerous collections, received at different periods, from every quarter of the globe. In the chapter on classification, Brefeld's researches are analysed, and his proposed system of classification given in a tabular form. Saccardo's arrangement of the fungi is also thoroughly explained and criticised, as "it will doubtless come into universal use where expedients are valued rather for their utility than their consistency." The above quotation refers to the elevation of the Friesian sub-genera of the Agaricini to generic rank by Saccardo; and, while admitting that there is an apparent trifling with a preconceived conception of generic value in elevating to the same level, the sub-genera and genera of the same author, more especially when the genera are so broad, as in the Friesian system; yet perhaps in these days utility is of more value than consistency in a purely systematic work, the real value of which depends on the ease with which the organisms of which it treats can be recognised, and this can usually be more readily accomplished by the use of artificial methods than by adhering strictly to a supposed uniform standard of relationship, at all events so far as species and genera are concerned.

The author advocates the continued use of the term *spore* for the reproductive body of the Basidiomycetes, and *sporidium* for that of the Ascomycetes; with this we cannot agree, considering *basidiospore* for the former, and *ascospore* for the latter as conveying more definite information, and further, freeing the subject from the very vague term spore.

We cannot accept either of the following statements, which certainly should be qualified in a future edition of the book. "Of the 9600 known species of Hymenomycetal Fungi, really parasitic species are almost, if not wholly unknown." "All the parasites on living leaves

which are not of insect origin, are Fungi." *Agaricus melleus* and many species of *Polyporus* are too well known as parasites, and in the tropics coriaceous leaves of evergreen plants are victims to the attacks of parasitic lichens and algæ; lichens are mentioned, as the author holds to his previous view, that these are entirely distinct from fungi, giving a summary of his views on this subject.

We should look elsewhere in vain for anything approaching the amount of information contained in the section devoted to the geographical distribution of fungi, a chapter which indicates not only what has been done, but also what remains to be done.

A noteworthy feature of the book is the full bibliography given at the end of each chapter, treating of the special subject dealt with. There is also a glossary explaining the scientific terms adopted. The index might with advantage have been fuller. The numerous illustrations have in most instances done service before, but nevertheless serve to elucidate the text; and on the whole it may be said that no one aspiring to the study of fungi from the systematic standpoint, can afford to ignore the present work.

GEO. MASSEE.

OUR BOOK SHELF.

Rambles in Japan, the Land of the Rising Sun. By H. B. Tristram, D.D., LL.D., F.R.S. With forty-five illustrations by Edward Whymper, from sketches and photographs. (London: The Religious Tract Society, 1895.)

CANON TRISTRAM has done well in putting together this record of a visit to Japan, which, although not "recent" when measured by the rapidity of the present march of Japanese history, occurred only a few years ago. The object of the visit was mainly to study the working of Christian missions on the spot; and this is a welcome fact, because it ensures an audience for what the author has to say, who cannot but profit greatly from the acute observations and calm judgments which he records. While making no pretensions to scientific treatment, Canon Tristram's book is to the average run of tourist twaddle on Japan, as a good novel is to a "penny dreadful." It is truthful, well-written, and inspires confidence. Under the guidance of his daughter, who as a missionary had acquired the Japanese language, Dr. Tristram visited some parts of the islands remote from the tourist-track, although all well-known to European residents in Japan. His instincts as a field-naturalist kept him on the alert for all that was to be seen of animal and plant life; and although we fear the precipitancy with which he yielded to temptation in the matter of ivory-carvings and rare china, must have told on his natural history collections, he seems to have brought back a good many plants, insects and birds.

A great number of interesting facts and phenomena are touched upon. The wonderful results of fancy gardening in Tokyo in dwarfing and grafting, seem to culminate in a maple-tree with seven large branches, the foliage of each having a different tint, varying from copper-colour to greenish-white. The art of the Japanese in domesticating such sensitive birds as robins, titmice and warblers, is cited as an instance of the great sympathy for nature which distinguishes the Japanese. Dr. Tristram found that the localities of many of the birds, brought to the seaports for sale, were wrongly described on the labels which were affixed in Europe, and he instances one case in which a species found only in the forests of Nikko, from 3000 to 8000 feet above the sea, had its habitat given as Yokohama. The author is inclined to rank Fujisan second in beauty to the Peak of Tenerife, and he remarks that no Japanese artist would think of painting this much-portrayed mountain from nature, but always from the paintings of the "old masters" of Japanese art. Richly wooded as Japan is, the universality of the use of charcoal as a domestic fuel has necessitated special forest-legislation, based on the strict system of re-planting practised in Germany. Although Dr. Tristram necessarily depended much on second-hand information, he avoids the familiar pitfalls of the uneducated writer, and but for a printer's error in the population of Nagoya, there seems little wanting in the way of accuracy.

The illustrations add greatly to the interest of the book; but while all of them are worthy of the name they bear, it is almost with a feeling of shock that one reads "Whymper" on several ordinary half-tone process blocks.

A Manual of Botany. By Prof. J. Reynolds Green, F.R.S., Sc.D., F.L.S. Vol. I. Morphology and Anatomy. Pp. x + 398. (London: J. and A. Churchill, 1895.)

PROF. GREEN has set himself a difficult task in attempting to put new wine into old bottles. Bentley's book, on which the present work is based, was admirable in its time, but to-day it strikes one as being somewhat inflexible both in style and ideas. It is true that in the volume before us there is a great deal of very useful information, which is put better and more clearly than elsewhere; in fact some of the subjects are so well treated, that we cannot help regretting that Prof. Green did not see his way to give us an altogether original work.

We notice, however, with regret, that the morphology of the inflorescence is here somewhat hazy, and it seems a pity that Eichler and Gray were not more closely followed, since their views, especially those advanced by the former, are certainly the most philosophical, as well as the most lucid and comprehensive of any which have as yet been put forward. The treatment accorded to the stele does not strike us very favourably; the student may be well forgiven if he abandons all attempts to understand the complex and apparently irreconcilable ideas embodied in the expressions "monostely" and "polystely" respectively.

The position of the axis should have been marked in the floral diagrams, as without it, one fails to recognise the correct orientation of the parts of the flower. This need is the more obvious in cases where the actual position of the axis varies in figures on the same page, as in Figs. 248 and 250, in which it falls above and at the side respectively.

But notwithstanding these faults, the book provides, on the whole, a clear and comprehensive account of the structure of plants.

Rope Driving. By John F. Flather, Ph.B., M.M.E. Pp. 230, and figs. 92. (New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1895.)

THIS is a handy little book on the transmission of power by means of rope gearing; it contains a large amount of sound information on the various arrangements of driving gear, and their design, the best speeds at which ropes should be run, and the tension to which they should be exposed. The reasons of decay and means of preservation of ropes are succinctly dealt with; as also are the relative advantages of cotton and manilla hemp ropes when worked under different conditions. The book is certainly worthy of a place in any technical library, as the subject is one which is daily engaging increased attention, affecting as it does the efficient driving of mills, factories, and electric installations, and the transmission of motive power to places more or less isolated from its source.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Cause of an Ice Age.

SEVERAL letters from Sir Henry Howorth, Dr. Hobson, Mr. Culverwell, and Prof. Darwin, having appeared in NATURE relating to my little book on the "Cause of an Ice Age," I shall be glad if you will allow me to make a few remarks on the matter. In his first letter, Sir Henry Howorth thinks I have omitted to give Wiener the credit which was justly his due. Subsequent letters by Dr. Hobson and Sir Henry Howorth may be held to have cleared up this matter; still there is a point which has escaped Sir Henry Howorth's attention, and I therefore refer to it again.

The facts are as follows. When I first began to work at the Ice Age I arrived independently, as any mathematician might easily have done, at a theorem by no means difficult, which seemed to me of importance in connection with the subject of geological climates. I had never seen this theorem before; had I done so I should, of course, have properly acknowledged its prior discovery.

Soon after the publication of my book, Prof. Darwin kindly pointed out to me that the mathematical theorem in question had been already given by Wiener. Thereupon I did all that it seemed possible to do. I called attention to Wiener's priority at once by a letter to NATURE, which appeared on February 18, 1892, and I also mentioned his priority both in the preface and the text of the second edition of the "Cause of an Ice Age," which was published in 1892. Sir Henry Howorth, when he wrote his recent letters in which he thought I had not rendered justice to Wiener, could not, I am sure, have known all the facts as above stated.

Mr. Culverwell thinks that I was wrong in attributing a certain opinion to Croll, and I quite admit that this charge might once have been correct. The fact is, I had been mistaken in the meaning I read into a passage in Croll's "Climate and Time," p. 56. But I think if Mr. Culverwell had known the circumstances, he would hardly have considered it necessary to raise this question again. On the appearance of the first edition of my book, the mistake I had made was kindly pointed out by Mr Monck, as well as by Mr. Noble, and I think by others; and I accordingly amended the second edition. In the *Geological Magazine* for February 1895, p 58, Mr. Culverwell appeals to me to correct certain passages relating to this point which he puts into italics from the first edition. My excellent friend had not the slightest notion that these passages had been already corrected in the second edition, published two years before his paper.

I must, however, say that on looking over my book again in connection with this correspondence, I consider that some of the references I have made to this particular point might be further amended. If, however, Sir Henry Howorth still thinks that I have at any time regarded Croll's work otherwise than with due respect, I would like to remind him of the words in both editions, p. 112, in which I said:—

"I was greatly struck by this work ('Climate and Time') when I first read it many years ago. Subsequent acquaintance with this volume, and also with his second work ('Climate and Cosmology'), has only increased my respect for the author's scientific sagacity, and my admiration for the patience and the skill with which he has collected and marshalled the evidence for the theory that he has urged so forcibly."

I have studied with much interest and profit the investigations made by Mr. Culverwell in connection with the astronomical theory of the Ice Age, and I may be permitted to say how glad I am that so excellent a mathematician and physicist should have had his attention drawn to this subject. I may, however, take this opportunity to explain why I have had to remain unconverted by certain of his arguments, notwithstanding that they have carried conviction to Sir Henry Howorth and Prof. Darwin.

In his earlier paper in the *Geological Magazine* for January 1895, p. 9, Mr. Culverwell has demonstrated that the direct sun-heat received on any parallel at the time of greatest eccentricity, is the same as that now received on the parallel not more than three or four degrees north. This seems to me not only a novel, but also a very instructive result, and is in any case a valuable contribution to the theory. Mr. Culverwell, however, goes on to deduce from this that the climatic change in England between the present time and the time of the greatest eccentricity, would be no greater than the present climatic difference between Yorkshire and Cornwall, and hence he concludes that the astronomical theory is incompetent to account for the Ice Age. Prof. Darwin seems to think that this argument is unanswerable; I hope he will forgive me if I say that here my dissent begins. I think the facts cited do not warrant the inference which Mr. Culverwell would draw from them. With due respect to Mr. Culverwell, I would say that he seems at this point to have quite forgotten that the actual temperature in a region depends not merely upon the sun-heat there received, but also upon the transference of heat across the boundaries of that region. He takes the actual temperatures of Yorkshire and Cornwall; but what his argument would really require is a totally different thing. It would be the temperatures of those counties if each of them were perennially surrounded by a wall extending to the top of the atmosphere, and adiabatic to all heat except direct solar radiation.

This point is so important that I must put it in a somewhat different manner. It is certain that the actual climatic gradient from the equator to the pole is very different from what that gradient would have been if each parallel of latitude had marked the course of an adiabatic barricade such that no heat transference *via* earth, air or water could take place from zone to zone. In the latter case I quite admit that the mean temperature due to the sun-heat received on any zone would be actually the mean temperature of that zone, but the same is not true of the actual climatic gradient as we have it in nature For, on account of heat transference, the mean temperature of a zone is by no means the same thing as the mean temperature due to the sunbeams received by that zone.

May I say that I think the fallacy throughout this part of Mr. Culverwell's argument arises from his overlooking the distinction between the actual gradient and the adiabatic gradient. There may be but little difference between the mean temperatures of a zone through Yorkshire, and a zone through Cornwall; but this does not prove, as Mr. Culverwell's theory requires, that there would be but little difference between a mean temperature due solely to the direct sun-heat falling on the zone through Yorkshire, and a mean temperature due solely to the direct sun-heat falling on the zone through Cornwall. This inference would only be sound if all parallels were adiabatic. This they certainly are not.

I do not question that the difference between present temperatures and the temperatures at the time of highest eccentricity might be fairly represented by the difference between the temperature due to the sun-heat received in the latitude of Yorkshire, and the sun-heat received in the latitude of Cornwall. What I do question are the grounds on which Mr. Culverwell maintains that this latter difference (and therefore the former one) is so insignificant as to discredit the astronomical theory of the Ice Age.

I have thus explained in what respect Mr. Culverwell's investigation involves assumptions which are in my opinion unsound. I am accordingly to this extent unable to accept the conclusions at which he has arrived. ROBERT S. BALL.

Observatory, Cambridge, January 2.

THE letter of Prof. G. H. Darwin in your last issue states very clearly the argument on which Mr. Culverwell and himself rely as affording a demonstration of the inadequacy of the astronomical theory. It now seems opportune, therefore, to lay before your readers the general considerations which lead me to the conclusion that the whole argument they rest upon is unsound; and, further, that Sir Robert Ball's ratio of 63 to 37, representing the ratios of sun-heat received by each hemisphere in summer and winter respectively, is (contrary to Prof. Darwin's view) an important factor in any adequate discussion of the problem.

Accepting Prof. Darwin's estimate that the difference in the amount of sun-heat received in our latitudes during high and low eccentricity, would only give to Yorkshire the amount received by London or *vice versa*, I entirely demur to his statement that this would be also a measure of the amount of change in the climates of these places To do so is to assume that the climate of a place, as regards the amount and distribution

of its temperature, is determined by one factor only—the amount of sun-heat it receives.

How very erroneous is this assumption, may be shown by the contrasted climates of places on the east and west sides of the Atlantic, due to the influence of both ocean-currents and prevalent winds; but even more strikingly by a comparison (which I made in my "Tropical Nature") between certain tropical and temperate climates. In Java, about 8° south of the equator, the altitude of the noonday sun in June is about 58½°, while at London during the same month it is 62°, the length of the day at the same time being 5½ hours greater with us. The sun-heat received in London must therefore be *considerably greater* than that received in Java, and, according to the rule that the *amount* of sun-heat determines temperature, London should then have the warmest climate. The fact, however, is that our mean temperature in June is more than 20° lower than that of Java and our mean highest temperature about 18° lower, a result due, as I have shown, to a variety of causes, of which the temperature of the atmosphere in all surrounding areas, the action of aqueous vapour in reducing the loss by radiation, and the accumulation of heat in the soil, are probably the most important. These facts prove, I think, that the amount of heat received by the whole hemisphere, through its influence on both oceanic and aerial currents, must be taken account of in estimating temperatures under different phases of eccentricity; and that any determination of the amounts of sun-heat received at particular latitudes, considered by themselves, are necessarily misleading and must usually indicate a difference of climate far below the truth.

But there is another consideration of even more importance which entirely invalidates the arguments of those who, like Mr. Culverwell and Prof. Darwin, treat the problem as one to be determined by a simple mathematical calculation of amounts of sun-heat received on the same area at different times. This is, the remarkable difference in the behaviour of air and liquid water on the one hand and snow and ice on the other, as regards climate; the former from their great mobility tending to the diffusion of heat, the latter by its comparative immobility to the accumulation and perpetuation of cold. Without this power of accumulation perpetual snow on tropical and temperate mountains, and glaciers in hot sub-alpine valleys and at only 705 feet above the sea-level in latitude 43° 35′ south in New Zealand, would be impossible. In either of these cases, if an elevation of about a thousand feet should double the area of the snow fields, which might easily be the case, the outflowing glaciers would be greatly increased in magnitude and might either descend to much lower levels or spread out over large areas of the lowlands—and all this without any change whatever in the total amount of sun-heat received by the countries in which they occur.[1]

For some years past there has been a persistent attack by astronomers and physicists on the explanation of the glacial epoch put forth by Croll and adopted with some modifications by many students of glacial phenomena. But as these writers have all treated the problem as a question of the direct effect of the amount of sun-heat received at different epochs in corresponding latitudes, completely ignoring the great distributing and accumulating agencies which are always and everywhere in action, their theoretical conclusions appear to us to be entirely beside the question. We have to deal with a highly complicated problem in physical meteorology, which cannot be solved by an appeal to the well-known facts of the amounts of sun-heat received, any more than can the June climates of London and Batavia or the general climates of Ireland and Manitoba or Terra-del-Fuego (in about the same latitude) be explained from similar data. The great merit of Croll was, that he fully realised the complexity of the problem; that he took account of the various relations and reactions of the oceanic and aerial currents, and the physical characteristics of air and water, snow and ice; and that he showed how these causes reacted on each other so that the winds and ocean currents of one hemisphere might have an influence on the accumulation of snow and ice in the other. Whatever errors he may have made in matters of detail, his method was undoubtedly a sound one, and it is because so many recent writers on the subject have wholly ignored his method without even attempting to prove that it is erroneous, that their views appear to us to be both retrograde and scientifically unsound.

ALFRED R. WALLACE.

[1] This remarkable property and its effects are explained in some detail in my "Island Life," p. 131 (second edition), under the heading "Properties of Air and Water, Snow and Ice, in Relation to Climate," and in the four following sections.

The Dying out of Naturalists.

THE dying out of the distinguished school of "naturalists" which this country once produced, and which culminated in Darwin, is a fact which scarcely admits of dispute. I am informed on good authority that it has not escaped the notice of the French scientific world.

I drew attention to it in the address which I delivered to the new Botanical Section of the British Association at Ipswich. I rather described the phenomenon than attempted to explain its causes. But what I said has brought me many interesting communications. It has been suggested to me that as far as botany is concerned, I have much myself to be responsible for. It may be so. But this I may say, that in entering the laboratory I did so with the natural history spirit. I only looked at interesting things with a closer vision. So, if I may go to the other end of the scale, did Darwin when he made use of all the newer appliances of biological research in his later work.

Nothing, it seems to me, is more difficult than to trace to their right causes the springs of human endeavour. Its results are familiar to us, because we live amongst them. We are so prone to assume "motives" off-hand for any human action that we see about us, that nothing seems easier than to explain any new departure that comes in our way. But the process is almost certainly superficial, and the real causes of a social change which breaks upon us suddenly have in all probability been of slow growth, and do not at the moment either reveal themselves or readily lend themselves to analysis.

A friend, a well-known naturalist, gives me his explanation. I suppress his name, as I have not his permission to quote it; but I think what he says is worth printing, as affording ground for reflection. Whether the cause he assigns is or is not well founded, I confess I do not know.

But generalising from experience I can say this: all distinguished naturalists whom I have known have gone ahead in defiance of any and every obstacle. Looking back upon their lives, it was as if fate had conditioned them. It was once said to me that if one ever came across a possible artist of merit, the right thing to do would be to offer him every discouragement. If he had real genius he would transcend his ordeals; if he had not, the world would not be appreciably the poorer if he was quenched.

But I must discriminate. English naturalists of the generation which is now passing away have belonged to two groups. Some have been born to wealth, some to poverty. Class prejudice was against the one; means of livelihood against the other. The richer disciples of our art seem now to have gone irretrievably, and to have no successors. The poorer have changed their tone; they tend to treat science as a career like the Civil Service. They approach those who have any hand in the matter in an extremely business-like spirit. I do not blame them. But this is not the *métier* of the scientific hero. Nor in their memory shall we assemble to found a national memorial or raise a statue.

What is the force that now-a-days quenches the old enthusiasm? My correspondent says that it is the schools, and here is his story. I believe that, at any rate, what he says is the outcome of sincere conviction, or I would not publish it.

"I am pleased to see your remarks upon the dying out of the study of systematic botany, and I see in other papers, too, attention called to this and the diminution of field naturalists. One starts one's natural history usually on these lines when a boy—or, rather, used to—but I noticed things had altered much when I visited my old school last winter. In my day we had lots of naturalist boys; we knew all the localities for insects, plants, shells, &c. Now hardly any one knows anything of the country beyond the playing fields. The 'skipper field,' famous for skipper butterflies; the heath, with its localities for all kinds of insects and plants, are absolutely unknown. The great object of education appears to be to have every boy competing for something absolutely useless to him in later life. They were practising cricket or other games, or cramming for exams. all the while. This remarkable system begins, the masters of this and other schools told me, at about eight years old. There is no time to learn to think or observe. The boys must beat some other school in tennis or football, or must beat some one else in the history of the Punic Wars. Science was taught, but much in the same way. They were neither taught, nor did they get a chance of teaching themselves, any natural history. What the result of this will be it is difficult to foresee, but it certainly accounts a good deal for the diminution in systematists and field-naturalists."

W. T. THISELTON-DYER.

Royal Gardens, Kew, December 27, 1895.

Pendulum Observations in the Northern and Southern Hemispheres.

THE figure of the earth has been determined by three independent methods of investigation. (1) By abstract mathematical calculation of the form which such a body as the earth, rotating as it does, would assume when plastic. (2) By careful measurements of arcs on meridian lines in different latitudes. (3) By pendulum experiments, which have indicated a gradual increase of the force of gravity from the equator towards the poles.

These three methods, after necessary corrections have been applied, correspond so nearly in their results that probably we have ascertained the true ellipticity of our earth as nearly as is possible considering the irregularities of its surface. But there is one point in connection with pendulum experiments which, although it cannot have escaped notice, has not been treated of, as far as I am aware, in any work on astronomy or geodesy, viz. that all the pendulum experiments hitherto made in the southern hemisphere indicate that the force of the earth's attraction is less in that hemisphere than in the northern. The great navigator, Captain Cook, was the first, I believe, to notice this phenomenon in connection with an excellent pendulum clock which he carried with him. He noticed that this clock always went slower at places in the southern hemisphere than it did in the northern hemisphere; but he did not pursue the question.

In November 1893, Dr. John Murray read a paper on Antarctic research before the Royal Geographical Society, and in the appendix to that paper is a communication from Dr. Neumayer, of the Hamburgh Naval Observatory, giving a table of the results of pendulum experiments hitherto made in the southern hemisphere. In the annexed table I have made use of Dr. Neumayer's collected information, reducing his values of the length of pendulum beating seconds, given in metres, to the corresponding values of the accelerating force of gravity in foot seconds, and I have added, from other sources available to me here, the corresponding values of *g* at places in nearly similar north latitudes. By comparison it will be seen that the force of gravity in the northern hemisphere exceeds that in the southern hemisphere, in latitudes between 38° and 62°, by a mean of about ·010. In Dr. Neumayer's table, experiments in the southern hemisphere are recorded as far as lat. 33° 2′ 5″ S. (Valparaiso), but I have not been able to obtain here any records in similar latitudes in the northern hemisphere. In the northern hemisphere experiments have been made at Hammerfest 70° 40′ north latitude, and at Spitzbergen 79° 49′ 54″ north latitude; but no corresponding experiments have yet been made in Antarctic regions.

Taking, however, the values of *g* at Edinburgh and at Cape Horn, in very nearly the same latitudes, 55° north and south, viz. 32·204 and 32·194, and assuming that these values will not vary greatly in their difference at the poles; by a simple calculation we find that the centre of gravity of the earth is approximately $\frac{1}{10}$ths of a mile north of the plane of the equator. It would appear from this that in astronomical observations depending on zenith distances, and consequently on the direction of the plumb-line, not only must corrections be made for the ellipticity of the earth, but also for the true position of the centre of gravity of the earth, which at the equator must deflect the plumb-line about 15″ from the true vertical.

It is a deeply interesting question whether astronomical observations can be, or have been, made to verify the results obtained by the pendulum.

Geographically it is a subject which may approximately be investigated by comparing the masses of dry land now standing above the sea-level in the northern and southern hemispheres; the excess of dry land in the northern hemisphere, at present, being the probable cause of shift of the centre of gravity of the earth northwards.

In mathematical astronomy it presents an extremely difficult but highly important problem, viz. what effect this position of the centre of gravity of the earth has upon the gyratory motion, producing the precession of the equinoxes, which is caused by the attractions of the sun and moon on the equatorial protuberance.

If, as seems probable, a shift in the position of the centre of gravity of the earth north or south of the plane of the equator must produce a shift also in the direction of the axis of gyration, many perplexing geological problems as to varying climates in the same part of the world during different epochs in the world's past history would be at least partially elucidated. There is ample evidence of very widely-extended earth movements of elevation and depression in the past; these must have varied the balance of the earth, and if a change in the balance produces also a change in the direction of the axis of gyration, a change in climate follows as a matter of course.

It is a problem requiring mathematical genius and skill of the highest order for its solution; but it can be hardly denied that it is of very great scientific interest that it should be correctly solved.

Finally, I would wish to draw attention to the importance of accurate pendulum experiments being made in the highest southern latitudes attainable by the Antarctic research parties which are either now being organised, or will, it is hoped, eventually be despatched by the British Government.

Place.	N. lat.	Value of *g*. ft.sec.	Diff.	Value of *g*.ft. sec.	S. lat.	Place.
Washington, U.S.A.	38° 54′	32·1558	·013	32·142	37° 49′ 9″	Melbourne.
Paris	48° 50′	32·183	·009	32·174	49° 8′ 9″	Kerguelen Island.
			·011	32·182	51° 31′ 7″	Falkland Is. No. 1.
				32·178	51° 35′ 3″	Falkland Is. No. 2.
Greenwich ...	51° 29′	32·191		32·180		Mean of Nos. 1 and 2.
Belfast ...	54° 36′	32·199	·008	32·191	54° 31′	S. Georgia
Edinburgh ...	55° 27′	32·204	·010	32·1936	55° 51′ 3″	Cape Horn.
N. Shetlands	60° 45′	32·217				
Interpolated ... (at the rate of ·00275 per degree)	62° 45′	32·222	·010	32·212	62° 56′ 2″	S. Shetlands.

N.B.—The difference in the values of *g* between Washington and Melbourne, if corrected for difference in latitude, would become ·011. Similarly that between Paris and Kerguelen Island would become ·010. The variation in the difference at 54°.$\frac{31}{36}$ south and north latitudes may be due to some local attraction or some inaccuracy in observation.

Wellington, New Zealand, November 12, 1895. H. S. SCHAW.

The Metric System.

IT may not be within the recollection of your readers, and very unlikely to be so in that of the British public, that so far back as 1870–71 the Government of India, in the Governor-General's Council, passed an Act to introduce the metric system into the British dominions in India. However, as all Acts passed by that Government and its Council require the prior sanction of the Secretary of State for India in Council, the measure failed to take its place on the Statute Book of the Empire. His Grace the Duke of Argyle was at that time at the India Office, and it is a matter for much regret that he did not see fit to approve of the measure. That the Government of India did not expect that the Act would be vetoed, is proved by the fact of its having adopted the system in the State Railway Branch of the Public Works Department, then but recently formed. Sir Guildford Molesworth, K.C.I.E., then Consulting Engineer to the Government of India for Railways, published a series of type drawings dimensioned in the metric system. The Government further adopted the metre as the gauge of the narrow-gauge system then introduced for the first time by them. All the platform and other weighing machines sent out were so arranged as to weigh in kilogrammes, tons, and maunds. Had the wise policy of the late Lord Mayo been then approved of, the English commercial and scientific public would not now be clamouring for its adoption in the mother-country, as its great advantages would be patent to all.

In Ceylon the decimal system has been applied to the rupee, and I have not heard any complaints of inconvenience having arisen from such adoption.

Cannot a further agitation be started, to move the Government of England to take steps in the coming session to make a start, at least, in the matter? It might be notified that, for all Government contracts, no other system would be entertained after January 1, 1898. This in itself would give a huge impetus to the movement. F G. BROOK-FOX.

West Kensington, W., December 26, 1895.

The Habits of the Cuckoo.

IN connection with the interesting article in NATURE of Dec. 26, 1895, on the habits of the common cuckoo, it may be of interest to some of your readers to record the following observations, which afford further evidence in support of the contention that the cuckoo occasionally lays its egg before carrying it to the nest in which it is to be deposited.

A few seasons ago, a pair of robins built in the ivy covering the walls of our house. It was cunningly concealed, about five feet from the ground, in a hollow formed between the wall and the interlacing stems of the ivy. The nest was successfully finished, and four or five eggs were laid. One day, in the early hours of the afternoon, the loud notes of a female cuckoo attracted our attention. Almost immediately afterwards we saw the bird on one of the branches of a large yew-tree growing close to the corner of the house where the nest, was placed, and one of our party exclaimed, "Oh! it is holding something in its beak." It seemed in no way disturbed by the close proximity of the house and its inhabitants, and, after a moment's pause, flew down and disappeared behind the angle of the wall. It then quickly reappeared and flew away, making a considerable noise. We immediately went to the nest, and found the cuckoo's egg together with the robin's. The entrance to the robin's nest, and the entire hollow where it lay, was far too small to admit so large a bird as the cuckoo; the short time, also, that the bird was there, presumably points to the fact that it carried its egg thither and simply placed it in the nest.

Some years before, much the same thing occurred in the same garden. In this instance the robin's nest was in a hole in a bank, which was also too small to easily admit the cuckoo. The parent robins were seen furiously attacking the larger bird, who was forced to beat a retreat. But it had already deposited its egg in the robin's nest, where we found it immediately afterwards.

London, December 29, 1895. ANNIE LEY.

A Luminous Centipede.

WAS not the insect seen by Miss Rose Haig Thomas (see NATURE, p. 131) a specimen of the Myriapod *Scolopendra electrica*, or *Geophilus electricus*, a well-known luminous insect whose light is but rarely seen owing to the insect living underground and in manure heaps? It is, however, the only luminous British species. I have but once seen one crawling abroad at night, but I know the insect well. It may be readily captured in the daytime. The light is bright and the colour is the same as that of the glow-worm. According to my observation both sexes are luminous, and the light is not peculiar to the summer season, as is that of the British glow-worm, hence the meeting of the sexes can scarcely be the object of the luminous prevision.

Worcester, December 20, 1895. J. LLOYD BOZWARD.

IT is impossible to give an unqualified reply in the negative to Mr. Lloyd Bozward's question; but for reasons stated in the note appended to Miss Rose Haig Thomas's communication, I see no grounds for doubting that the specimen she observed was an example of *Linotænia crassipes*, and not of *Geophilus electricus* (= *Scolopendra electrica*, Linn.). So far as my experience goes, the latter is very scarce in the south of England. It must be borne in mind, however, that there is no safety in the assumption that every luminous centipede found in this country is certainly referable either to one or the other of these two species. As a matter of fact, the family *Geophilidæ* is represented in England by at least a dozen species, belonging to five genera, and it is possible that all of them possess the property of phosphorescence. Perhaps it is not surprising that persons unacquainted with these facts jump to the conclusion that every luminous centipede they see must be co-specific with the one to which Linnæus gave the name *electricus*. This is so far from being the case, that not one of the many specimens that have been brought of late years to the British Museum, on account of its luminosity, has proved to be an example of this species. No doubt, however, there is much that might be learnt on this subject by the careful preservation of specimens, with particulars as to date, locality, &c., and I need hardly add that I shall be very pleased to identify any examples that are sent or brought to me at the British Museum for that purpose.

British Museum, Cromwell Road, S.W. R. I. POCOCK.

A Lecture Experiment on the Nodes of a Bell.

THE following modification of Chladni's method makes an interesting lecture experiment, and shows the nodal lines of a bell far more sharply and easily than any process already described of which I am aware. For the bell, use a cylindrical glass crystallising pan (say nine or ten inches diameter and four to six inches deep, but almost any size will do), and stand it, rim upwards, on three india-rubber corks. Some light-coloured powder, such as flowers of sulphur, is mixed with soapy water and smeared over the concave surface. The mixture should be quite watery, and can be applied by pouring a little into the bell, which is then tilted as much as possible and rotated round its axis. With one hand inside the bell, press it down firmly on the corks, and excite the rim with a bow. It is best to make double contact with the bow at two opposite points on the rim, and a succession of rapid strokes will produce strong vibrations, the powder meanwhile shooting upwards in arch-like curves, till it collects in four or six distinct vertical lines, easily visible at a distance if held against something black. Using a smaller vessel, smeared only half-way round, no doubt the whole process could be optically projected. G. OSBORN.

The Leys School. Cambridge.

The Critical Temperature of Hydrogen.

IF my allusion to the absence of "fresh experiments" in Dr. Natanson's work is not sufficient acknowledgment of its purely theoretical nature, a reference to my original abstract in the Physical Society's *Proceedings* will, I feel sure, correct any false impression that has arisen in the author's mind on that point. My note was in no way intended as a criticism or expression of opinion. But the Cracow *Bulletin* paper was certainly calculated to give any reader the idea that Dr. Natanson was the only worker besides Olszewski who had attempted to calculate the critical temperature of hydrogen, and, to prevent misunderstanding, a reference to Wroblewski's previous work seemed desirable. As Dr. Natanson still appears to pass over the long and laborious experiments on which the latter investigation was based, and to be unaware that the whole object was to get the critical constants, &c., *from the application of Van der Waals' theory* (which had previously given chemists an accurate knowledge of such data in the case of oxygen, nitrogen, and marsh-gas *before the gases had been actually liquefied*), I must refer *him* to Wroblewski's memoir. Further, it might interest him to consult a paper by Prof. Dewar in the *Philosophical Magazine* for September, 1884, which discusses the critical constants of hydrogen based on the experimental facts known at that time.

G. H. BRYAN.

THE SPERM WHALE AND ITS FOOD.

THE services which H.S.H. the Prince of Monaco has rendered to the science of oceanography, during the last ten or twelve years, are familiar to every one interested in that department of research. First in the small schooner *Hirondelle*, with no power but the strong arms of his Breton crew, and later, in the large and perfectly equipped auxiliary steam yacht *Princesse Alice*, there is no branch of the science which has not been enriched by his enlightened enterprise and his unwearied perseverance. It may be interesting to the readers of NATURE to know something of what was achieved in the summer cruise of 1895 in the waters of the North Atlantic, chiefly in the vicinity of the Azores. The dredging and other deep-sea operations conducted on board the yacht herself were very successful, and produced an abundant harvest. The most interesting result of the cruise, however, was due to the lucky chance of a cachalot or sperm whale being pursued by the whale-fishers of Terceira, and killed almost under the bows of the *Princesse Alice*, and to the prompt measures taken by the Prince to utilise this rare opportunity, the importance of which for science he immediately and intuitively perceived. The preliminary reports of the investigation of the material thus collected by the Prince, in collaboration with the Portuguese whalers, go to show

that an almost entirely new and unsuspected animal kingdom has been opened to the zoologist.

A general account of the nature of the results has just been given, under the title "Prise d'un Cachalot," to the Société des Naturalistes, at its meeting in the amphitheatre of the Museum of the Jardin des Plantes, on December 24; and two communications were made, on December 30, to the Academy of Sciences by the Prince, of which one was from Prof. Joubain, of Rennes, dealing especially with the specimens of gigantic cephalopods obtained. It will be convenient to give the proceedings of the yacht, during and after the capture of the cachalot, in the form of an abstract of the Prince's own communications, and to deal with the specific details of the animals collected, in the form of an abstract of Prof. Joubain's paper.

Proceedings of the Yacht.

On July 18 of last year, about nine o'clock in the morning, I observed, while engaged in operations in the deep water to the south of the island of Terceira, two boats leave the coast under sail, and about half an hour later two other boats proceeded in the same direction from another point. It was evident that they were not bound on an ordinary fishing expedition, and I quickly perceived that they were in pursuit of a school of sperm whales or cachalots; and I finished with the greatest speed the work in hand, in order to be able to take full advantage of the rare occasion of being able to assist at the capture of one of these interesting animals, should such be the result of the exertions of the whalers. About eleven o'clock I observed a whale spouting at a distance of about two miles, and I perceived that one of the whalers was approaching it cautiously. I was careful to remain at the same distance, in order not to run the risk of interfering with the whaler, and I closely followed all the manœuvres. The officer or coxswain of the boat stood erect in the stern, steering the boat with an oar. The harponeer stood in the bows, and I distinctly saw him strike the whale. I then approached the group at full speed, while the other whalers dispersed in pursuit of other members of the school. When I had arrived within one or two hundred metres, the cachalot had already towed the whaler attached to it by the harpoon, and the whole length of this line, to a considerable distance, and the harponeer had just succeeded in giving the animal the thrust of the lance, which terminates the struggle if skilfully delivered. The spray thrown out by the animal had become pink, and soon became quite red, while a pool of blood extended itself more and more on the surface of the water around. The *Princesse Alice* was lying at about one hundred metres from the animal when it turned slowly round, lashed out with its tail, and then came straight for the yacht at a speed of ten or twelve knots. As there are many records of whaling ships having been sunk by the cachalot under similar circumstances, it will not be wondered at if I confess to having experienced some anxiety during the approach of the whale, and when powerless to avoid it. Just, however, at the moment when I expected the shock, the whale sounded, passed under the keel without touching it, and reappeared on the other side in the agony of death. The rescue of the yacht from certain damage, if not from destruction, would have been impossible had the life of the whale been spared for a little longer. The cachalot was now floating alongside, with its head at a distance of about fifteen metres from the rudder, when its jaws opened and allowed several objects to escape, which I quickly recognised as cephalopods; but, notwithstanding the speed with which a boat was got away, in order to secure these animals, of the inestimable value of which I had already a presentiment, I perceived that they had begun to sink. On the spur of the moment, I started the engines very slow astern, and the coveted remains circulated slowly in the vortices produced by the propeller until they were secured by the boat.

The vessel now floated in a sea of blood of some acres in extent, and the whalers fixed one of our hawsers to the head of the dead animal; for they had gladly accepted my offer to tow it to El Negrito, where they have their installation for harvesting the oil from the whales that they are lucky enough to catch. The towing operation was not an easy one. The tail, acting as a rudder, caused the animal to swerve so violently from one side to another, that it was necessary to desist from the attempt to tow it head foremost, and to shift the tow-rope to the tail, after which the operation was completed without difficulty. The creek, which was the final destination of the whale, was not a suitable place for the yacht to remain; so, after landing the zoologists, MM. Richard and Lallier, and the artist, M. Borel, she left for the anchorage of Angra, while these gentlemen remained to assist at the breaking-up of the whale, with all the materials necessary for preserving the interesting matter which it promised to furnish.

For four days, under a burning sun, the whalers worked at removing the blubber and transferring it to the neighbouring house, where it was boiled down. At the same time they endeavoured to assist me in every way in securing the portions of the animal which interested me, more especially the brain. But the work was so difficult that it was only at the end of the fourth day that the skull was penetrated, and then the brain was found in a too advanced state of decomposition to be of use for preservation. It was impossible to approach the brain sooner, except by sacrificing the spermaceti, of which the volume was more than a cubic metre, and the commercial value very great. For half a day several men stood up to their middles in the cavity of the head which contains the spermaceti, and ladled it out. It must be remembered that the whale, which was stranded at high water, could only be worked at after the tide had ebbed considerably.

A large number of parasites were collected from the stomach, the digestive organs, the blubber, and the skin of the animal. M. Richard discovered on the lips of the whale certain round impressions, which he identified as the marks of the suckers of the great cephalopods. One can imagine the struggles of the giants which take place deep under the surface of the ocean. Notwithstanding his activity the cephalopod is seized by the cachalot, who, by means of the formidable teeth of the lower jaw, and the corresponding recesses in the upper jaw, holds the body of the animal without hope of escape. The cephalopod, in its defence, envelopes the face and head of the whale with the crown of its tentacles, the suckers of which leave deep impressions on its lips, and other parts where they have fastened. Meantime the cachalot makes efforts to swallow the portion of the cephalopod of which it has really taken possession, with the effect that the part of comparatively small calibre connecting the body with the head gives way; the body is swallowed, and the head dies and either drops off, or is eaten by the whale.

Zoological Details from Professor Joubain's Paper.

The sperm whale or cachalot (*Physeter macrocephalus*, Lacepède), caught on July 18, 1895, measured 13·7 metres in length. While in the act of death, it ejected several large cephalopods which it had only just swallowed, as was evident from their perfect state of preservation. Amongst them were three large specimens, each over one metre in length, of a species, probably new, of the little-known but interesting genus *Histioteuthis*. The bodies of two other immense cephalopods were collected at the same time. When the stomach of the cachalot was opened, it was found filled with a quantity, estimated at over one hundred kilogrammes, of the partially digested débris of these

cephalopods, all of them of enormous size. Amongst this débris may be noticed the crown and tentacles of a cephalopod, the body of which could not be found, belonging probably to the genus *Cucioteuthis*, hitherto known only by a few fragments. The muscular arms, which, though much shrunk and contracted by the preserving liquid, are as thick as those of a man, were covered with great suckers, each armed with a sharp claw, as powerful as those of the larger carnivora. More than one hundred of these suckers remain adhering to the arms.

The bodies of the two great cephalopods constitute one of the most interesting novelties of the scientific cruise of H.S.H. the Prince of Monaco. Their structure and their appearance are so different from all that is known amongst these animals, that it is impossible to place them in any species, genus, or family of this order. I propose for them the name of *Lepidoteuthis Grimaldii*, hoping that the discovery of complete specimens may permit of their affinities being more perfectly defined. One of these animals, half digested, is useless for study; the other, though headless, is much better preserved. It is a female, of which the body or visceral sac, after prolonged immersion in formol and alcohol, still measures 90 centimetres in length, from which it may be concluded that the length of the complete animal would exceed two metres. The surface of the sac is covered with large, solid, rhomboidal scales, arranged spirally like those of a pine cone. The fin (*nageoire*) is very powerful, and forms one half of the length of the body. It is not furnished with scales.

The stomach of the cachalot contained, besides, another cephalopod of large size, provided with a large fin, the skin of which enclosed certain photogenic organs. The head is wanting, so that it is impossible to affirm with certainty that it belongs to a new species, which is made very probable by the form of the body. Finally, the stomach of the cachalot contained a large number of beaks and rays or plumes, the difficultly digestible residue of former repasts.

The cachalot which was killed by the whalers of Terceira, almost under the keel of the *Princesse Alice*, seems as if it had been guided, in the pursuit of its food, by a desire to devour nothing but animals which, up to the present, are completely unknown, and in addition are of the highest importance for the morphology of the cephalopods. These cephalopods are all powerful swimmers, and very muscular. They appear to belong to the fauna of the deep intermediate waters, which is almost completely unknown, at least as regards the larger animals. They never come to the surface, nor do they lie on the bottom of the sea. Their great agility enables them to avoid every attempt to take them by nets; and it would appear that, for the present, the only means of capturing these interesting and gigantic animals is to commission a bigger giant to undertake the task, and to kill him in his turn when he has performed the service.

Accordingly, it is his Highness's intention for next season, either to add to the already very complete fittings of the *Princesse Alice* those of a sperm whaler, or to attach to her a special whaling tender. It need hardly be added, that the further working up of the unique material already collected is being pushed forward with the greatest energy, and the results will be awaited with interest and impatience.

J. Y. BUCHANAN.

NOTES.

MEN of science need no reminder that, however they may be separated by political or racial differences, they are united in the promotion of natural knowledge. Scientific academies and societies in every part of the world delight to admit foreign investigators into fellowship, and to show publicly, by various marks of appreciation, their regard for contributions to known facts of nature, and for assistance in interpreting those already garnered. But though these international amenities are common enough in the world of science, it is but rarely that the Government of one nation does honour to the distinguished men in another. We therefore notice with keen satisfaction that the French Government has just decorated a number of foreign investigators, in connection with the recent centenary of the Institute. Prof. Max Müller has been appointed Commander of the Legion of Honour, and Lord Rayleigh and Prof. Ramsay have been created Officers. The broad feeling that prompted these awards was the same as that which led the French Government to strike special medals to commemorate the late Dr. Hind's discovery of asteroids, and Janssen and Lockyer's method of observing solar prominences in full sunshine; and, more recently, it inspired the Paris Municipal Council to make arrangements for erecting a statue of Newton in Paris. In sharp contrast to the delicate compliments which the French Government and people pay to British science is the insularity which regulates the distribution of those honours that the British Government have at their disposal. So few and so belated, indeed, are the honours conferred upon men of science in our own country, that it is almost vain to think that her Majesty's advisers will one day have the magnanimity to do honour to investigators of other nations. We cherish the hope that the New Year decorations just given to British men of science by France will induce our own Government to return the courtesy.

M. BERTRAND AND M. BERTHELOT, Secrétaires Perpétuels of the Paris Academy of Sciences, have been made Grand Officers of the Legion of Honour. M. Maspero, the distinguished Egyptologist, has been appointed Commander, while Dr. Duclaux, Director of the Pasteur Institute, and MM. Grimaux and Moissan, the eminent chemists, have been created Officers of the same Order. Thus does France honour those who have established their claim "rightly to be great."

PROF. MARK W. HARRINGTON, late Chief of the United States Weather Bureau, and now President of the University of Washington, proposes to establish in the University a department of Terrestrial Physics and Geography, and he would be glad if authors and publishers would send to the University publications relating to these subjects.

A SOCIETY was legally registered in Paris a few days ago, having for its object the propagation of Pasteur's methods in medical treatment. The Administrative Council consists of MM. Duclaux, J. B. Pasteur, Roux, and Radot. The present capital of the Society is £400, in one hundred shares of £4 each, all of which have been taken up.

WHILE all interested in geology will rejoice at the recognition of the services to science and the State rendered by Sir Joseph Prestwich, they will regret to learn he is still in an extremely weak state of health and confined to his bed. Although he has regained a little strength, his convalescence must of necessity be slow.

PROF. SOLLAS, F.R.S., will leave in March for Sydney, to take charge of an expedition that is being despatched to make deep borings in a coral atoll. The scheme, which is supported by a strong scientific committee, has been financed by the Royal Society to the extent of £800; and the Government are placing a gunboat at the disposal of the party, to convey them from Sydney to Funifuti, in the Central Pacific, which has been selected as the scene of operations.

DR. DONALDSON SMITH read an interesting paper at the Geographical Society's meeting, last Monday, on his recent journey from Somaliland to Lake Rudolf. He told the story of the adventures of his expedition during the performance of this feat. The results of the journey are of great scientific importance. Dr. Smith has prepared a useful map, based on careful astronomical observations, of the region to the north and north-east of Lakes Rudolf and Stephanie, which has not hitherto been explored. He has also carried a chain of observations across the Borana country, between the Juba and Lake Rudolf. The collections proved of exceptional interest: in Somaliland, Dr. Smith has discovered an avifauna which is most closely allied to that of the Cape. This is in harmony with some other available evidence, and suggests a former immigration into East Africa from land now submerged beneath the Indian Ocean. He has found in the Borana country a fossil which proves the occurrence of Lower Oolitic rocks there; and thus shows the line of connection between the Jurassic beds of Mombasa with those of Shoa and Somaliland. He has also had exceptional opportunities of study of a dwarf tribe, first reported by Harris in 1844, members of which have only been seen twice previously. Dr. Smith's study of the hydrography of the region around Lake Stephanie has thrown light on the famous controversy as to the course of the Omo, though his observations do not settle it.

THE fact that calcium carbide is now obtainable commercially has been ingeniously applied by M. G. Trouvé for the purposes of domestic lighting. The principle of his lamp is that of the "Kipp" used in chemical laboratories, in various forms, for the production of hydrogen sulphide and other gases. The mode of arranging the contact of the water and carbide had to be carefully worked out, as an ordinary "Kipp," charged with calcium carbide and water, gives such a vigorous evolution of acetylene as to be unmanageable. An estimate of the working cost of the lamp compared with that of coal gas is favourable to the former in Paris, where gas is costly (7*s.* per 1000 feet); but in London, if the carbide could be obtained at the same price (4½*d.* per lb.), the cost would still be double that of ordinary lighting gas.

SOME interesting investigations on the vitality of typhoid bacilli inoculated into oysters have been carried out by Mr. Charles Foote. It appears that during the first fortnight following the introduction of the typhoid bacilli, undoubted multiplication of these microbes took place, but after that time had elapsed a steady decline in numbers was observed. The presence of typhoid bacilli within the oyster was, however, still demonstrable even thirty days after they were first introduced, and they were, moreover, observed in the stomach of the oyster, where they remained unimpaired in a vital condition. In some other experiments the water in which the oysters were immersed was also inoculated with typhoid bacilli, and it was actually found that they lived longer within the body of the oyster than in the water in which the latter was preserved. These investigations materially assist in justifying the hypothesis as to the possible contraction of typhoid through the consumption of oysters.

THE *Publishers' Circular* states that the number of new books issued in England in the course of last year was 5581, and of new editions 935, making a total of 6516 publications. By dividing these works into thirteen classes, an idea is given of the kinds of literature which make up this total. In the educational, classical, and philological class, 660 new-books were published, and 111 new editions. These numbers are a little in advance of those of previous years. The number of new books classified under "Arts, Sciences, and Illustrated Works" is 96, in addition to 16 new editions. But no definite idea with reference to the issue of scientific books can be obtained from these figures, owing to the unsound system of classification adopted. Why illustrated works should be classified with scientific works passes our comprehension. Moreover, there is something wrong about the figures, for in science alone we noticed in these columns last year many more than sixteen new editions of British books. Under the heading "Voyages, Travels, Geographical Research," 263 new books are given and 75 new editions. This was a slight decrease on the publications of 1894. In medicine, surgery, &c., 153 new books were issued and 53 new editions, this being a remarkable increase on the issues of the previous year.

WE note that the table of mean values for pressure, temperature, rainfall, and bright sunshine, which is published in the *Daily Weather Report* issued by the Meteorological Office, has been materially improved this year. In the first place, five more years of observations have been added to those from which the monthly means for each of the elements are calculated. Secondly, new columns have been added, showing the absolute maximum and minimum temperatures recorded during the month and the years in which such extremes occurred. The mean values are now mainly for the twenty-five years 1871–95, and the extreme readings afford valuable information as to whether the maximum and minimum temperatures recorded during each month are exceptionally high or low for the season. A glance at the table for January shows, for instance, that during the last twenty-five years the highest temperature recorded at any station included in it, in that month was 59° at Nairn and Cambridge, and the lowest, – 4° at Wick. Sunshine values at a few more stations would further enhance the value of this otherwise very complete *Report*.

THE "Triton" Society for the study of Aquaria and Terraria in Berlin has recently announced its intention of awarding prizes to the amount of 1500 M. for the best original solutions of certain problems connected with the management of fresh-water aquaria. The competition is open to all, and the problems in question are as follows:—(1) A method for the destruction of the more injurious ectoparasites of fishes, *e.g.* Gyrodactylus, Ichthyophthirius, Chilodon, Myxosporidia; (2) a method of exterminating the fresh-water polyp, Hydra, from aquaria; and (3) a method for exterminating the tube-worm, *Tubifex rivulorum*, from aquaria. In all three cases the methods recommended must be simple, easy to carry out, and effective in their results; but, while fatal to the particular organisms mentioned, they must have no injurious effect upon the fish and plant life of the aquarium. The essays must contain exact accounts of the methods recommended, and full descriptions of the experimental evidence upon which they are based, so that the methods may be readily and accurately repeated. Competitors must write in one of the recognised European languages, and must forward their essays by July 1, 1897, to Prof. F. E. Schulze, Direktor des zool. Instituts, Berlin N., Invalidenstrasse 43. The adjudicators will be Profs. F. E. Schulze and K. Möbius, and Drs. Haack, Hofer, and Schillinger. For the first problem two prizes will be awarded of 700 M. and 400 M. respectively; for each of the remaining problems a prize of 200 M. will be awarded. The Minister of Agriculture will also place two State medals in the hands of the adjudicators for award. Further information in regard to the competition will be found in *Der Zoologische Garten*, Frankfurt, vol. xxxvi. No. 9, 1895, pp. 285, 286.

THE annual general meeting of the Institution of Mechanical Engineers will be held on Thursday evening, January 30, and Friday evening, January 31. The annual report of the Council will be presented to the meeting on Thursday. The retiring President, Prof. Alexander B. W. Kennedy, F.R.S., will induct into the chair the President-elect, Mr. E. Windsor Richards.

The following papers will then be read and discussed, as far as time permits: "Telemeters and Range-finders for Naval and other Purposes," by Profs. Barr and Stroud; "Calculation of Horse-power for Marine Propulsion," by Lieut.-Colonel Thomas English; "Notes on Steam Superheating," by Mr. William H. Patchell.

THE Home Secretary has just issued the following order:—(1) The Wild Birds Protection Act, 1880, shall apply within the administrative county of the Parts of Kesteven, Lincolnshire, to the following wild birds, viz.:—Kestrel, merlin, hobby, common buzzard, honey buzzard, swallow, house martin, sand martin, swift, and wryneck, as if those species were included in the schedule to the Act. (2) The taking or destroying of the eggs of the following wild birds is prohibited within the administrative county of the Parts of Kesteven, Lincolnshire, viz.: Goldfinch, kingfisher, nightjar, nightingale, owls (of all species), ruff or reeve, woodpecker, kestrel, merlin, hobby, common buzzard, honey buzzard, swallow, house martin, sand martin, swift, wryneck, teal, and wild ducks (of all species)."

THE last published number of the U.S. *Weather Review* (June 1895) contains some interesting notes on the early history of weather telegraphy. The Morse telegraph was put into operation between Baltimore and New York on May 27, 1844, and it is said that a few days only had elapsed before the operators began to forewarn each other of the more important weather changes. In the *American Journal of Science and Arts*, vol. ii. 1846, Mr. W. C. Redfield notified that the approach of a gale, when the storm was yet on the Gulf of Mexico, or in the Western States, might be made known by means of the electric telegraph. A similar opinion, by Prof. Loomis, was published in the Second Annual Report of the Smithsonian Institution for the year 1847. A remarkable enterprise was undertaken by a news agency in New York; on January 24, 1848, Messrs. Jones and Co. advertised that they had made arrangements to give daily and hourly reports of meteorological phenomena from all parts of the country which were in telegraphic communication with New York; this advertisement appeared in *Silliman's American Journal of Science* for March 1848. The subsequent steady development of telegraphic weather reports culminated in the publication of daily maps; further particulars respecting the early development of meteorological telegraphy will be found in "Weather Charts and Storm Warnings," by Mr. R. H. Scott.

AN apparatus which illustrates all the laws of falling bodies, and also shows the tension or force acting upon them, is described by K. Hrabowski in *Wiedemann's Annalen*. It consists of a carriage moving on a single rail, somewhat on the Lartigue railway system, pulled by a weight drawn over a pulley, the string being connected to the carriage by a spring moving up and down in a vertical tube. To the upper end of the spring a pencil is attached, which moves along a vertical plate, and leaves a mark as the carriage runs along. When the carriage is at rest, the pencil stops at the point indicating the amount of the moving weight. Immediately on starting, the spring contracts, and the pencil-point traces a curved line which gives the force acting upon the carriage at every point. The line becomes horizontal when the carriage and weight have equal velocities, the tension in the spring being then just sufficient to overcome friction, and the amount of the latter may also be seen at a glance. By inclining the rail, the phenomena of acceleration downwards, or retardation upwards, may be easily studied. The apparatus is cheap, and should form a useful adjunct to science classes.

THE following account of the method used by the Bushmen of Namaqualand to poison their arrows is given in the *Scientific African*:—"Many methods of preparing the poison have been described, and according to some the poison is said to be extracted from the root of the plant, *Buphane toxicaria*, or Gift-bol, but it seems that the extract is only used as a resin. Some resin, either from the Gift-bol or from one of the members of the Euphorbia group of cactus-like plants, is first obtained, and the sticky substance is placed on a stone. The Bushman then goes with a forked stick to look for the 'ring-halse' or black night-adder, not the puff-adder which is called the ring-halse. Having found the snake, by a dexterous thrust of the stick the animal is imprisoned just behind the head by the two prongs of the stick. The prepared stone is then placed in the mouth, and the upper jaw forced right back. By this somewhat rough treatment the poison glands become compressed, and two drops of poison forced out on the fangs and caught on the stone. The poison is then well mixed with the resinous matter, and is ready for use. In the earlier days a more complicated procedure was adopted, through the medium of the witch-doctor. The whole head of the puff-adder was obtained and put in a pot along with the resin, and beetles and noxious herbs added to the incantation of the witch-doctor. The whole was stewed up amid great excitement. When the contents of the vessel were properly mixed, the sticky compound was collected by stirring it with a stick, to which the matter adhered, and on becoming cold, remained on the stick as a black knob, and formed then an article of barter."

A DESCRIPTION of the gold fields of the Southern Appalachians, based on a recent survey by Mr. G. F. Becker, forms part of the latest volume of the "Mineral Resources of the United States." There are a few small placer deposits in this field, which afford but little gold. They are of interest, however, in that they furnish undoubted proofs, in Mr. Becker's opinion, that alluvial gold is not formed by accretion, but by the wearing down of particles already present as such in quartz lodes. He accounts for the high standard of alluvial gold, and especially for that of the outer layers of nuggets, by assuming that the silver and other impurities have been removed in solution by running water; and he clinches his argument by quoting the opinion of Orviedo, one of the lieutenants of Columbus. Mr. Becker further narrates how he has traced the complete transition from hard auriferous quartz to true placer gravels through a series of "saprolites," a name proposed by him to designate "thoroughly decomposed, earthy, but untransported rock." He distinguishes them as "granitic saprolite" and the like, and claims that the use of such a term would be very convenient. The other gold deposits of the Appalachians are mainly true lodes, occupying fissures which run across the planes of stratification and have been formed by purely mechanical action. In this the author differs from Mr. J. A. Phillips, who thought they were "segregation veins." In whatever manner the veins may have been formed, however, there can be no doubt about some deposits of a slightly different kind occurring in Carolina, and bearing much resemblance to the *fahlbands* of Norway. These Carolina *fahlbands* are extensive lens-shaped masses of rock, which are conformable to the general schistose structure of the country, and are charged with disseminated pyrites and gold. Quartz stringers and veins appear close to and even in the rock masses, but, curiously enough, are barren. It is evident that the *fahlbands* have been enriched by impregnation with solutions containing gold, and also that no true segregation has occurred in these cases.

THE production and application of anti-toxic serum in the treatment of rabies has naturally been regarded as a subject the study of which could only be a question of time. The preliminary experiments on this subject made by Messrs. Babès and Lepp in 1889, had not been followed by any great advance in this direction until this year, when a most elaborate and weighty

memoir on the preparation of anti-rabic serum has been contributed to the *Atti della Reale Accademia delle Scienze dell' Istituto di Bologna*, by Messrs. Tizzoni and Centanni. The authors have succeeded in obtaining a powerful anti-rabic serum from sheep by inoculating them seventeen times in the course of twenty days with attenuated nerve-substance obtained from rabid animals, which is introduced in the proportion of 0·75 grm. per kgr. weight of the animal to be treated. Already a few minutes after the serum has been subcutaneously injected, the blood has acquired immunising properties, a result which with Pasteur's anti-rabic method is only obtained after several days, and then not invariably. As a *preventive* measure the authors state that 1½ drops of serum is sufficient to protect an animal weighing 2 kgr. inoculated twenty-four hours later with dog virus. As a *curative* measure the subcutaneous inoculation of 1 cubic centimetre even eight days after the animal has been infected with rabies, and therefore in the middle of the incubation period, is sufficient to stay all further progress of the disease. With this anti-rabic serum, Messrs. Tizzoni and Centanni have been easily able to render rabbits—these animals being especially susceptible to rabies—immune, a result only accomplished under exceptional circumstances by Pasteur's method. Rabbits again, even after the disease has made considerable progress, can be saved by a single subcutaneous injection of anti-rabic serum, whilst the Pasteur method under such conditions has never succeeded in curing them. The authors claim for their method that it is more efficacious, and at the same time less cumbrous than that at present in use. The serum is readily transferable, as it can be desiccated, and kept in bottles, protected from light, for a long time without undergoing any detriment. It thus can be forwarded to all parts of the world, and can be employed by local physicians, therefore preventing delay in treatment, and the necessity of the patient travelling to be treated in special institutes. The further application of anti-rabic serum will be watched with the greatest interest, and the verdict which time and experience alone can furnish will be anxiously awaited.

THE forthcoming number of the *Physical Review* will contain articles on the photometry of differently-coloured lights and the "Flicker" photometer, by Prof. Frank P. Whitman; the chemical potential of the metals, by Mr. Wilder D. Bancroft; and on the freezing-points of dilute aqueous solutions, by Mr. E. H. Loomis.

MESSRS. G. PHILIP AND SON have just published a special coloured map of British Guiana, to illustrate the Venezula-Guiana boundary dispute. The map shows clearly British and Venezuelan territories and claims, the original and modified Schomburgk lines, gold-mining districts, and many other features of the region surrounding the disputed area.

AT the celebration of the second centenary of the death of Christian Huygens, held at Amsterdam in July 1895, Dr. J. Bosscha delivered before the University a valuable address on the life and work of that rare genius. It will interest many of our readers to know that this address, with numerous details appended to it, has been published by Wilhelm Engelmann, Leipzig.

AN illustrated paper "On the Entomology of the Illinois River and Adjacent Waters," by Mr. C. A. Hart, is published in the *Bulletin* of the Illinois State Laboratory of Natural History (vol. iv. pp. 149–273, 1895). The paper gives a part of the results of observation and study of the insect fauna of the Illinois River and adjoining waters in the neighbourhood of the University of Illinois Biological Experiment Station, at Havana, Illinois, during the first year of the station work.

THE "Brief Sketch" of the meteorology of the Bombay Presidency for the year 1894–95 shows that the rainfall of the year 1894 was exceptionally good. During the month of July it was excessively heavy, owing to three severe cyclones, whereby disastrous floods were caused in various districts. The abnormally heavy rainfall on the Ghauts converted the mountain streams into rushing torrents, which swept everything before them, and rendered railway traffic impossible. At Surat a sudden rush raised the level of the river four feet within a quarter of an hour; communication was cut off with all surrounding villages, causing great loss of life from starvation or drowning. It is satisfactory to note that little or no damage was done in the town of Bombay by the immense quantity of rain which fell, owing to the great improvements that have been made in the drainage during the past few years.

LAST year's volume of the *Journal of Conchology* (vol. viii.), which was founded in 1874 by Mr. J. W. Taylor, of Leeds, and ably conducted by him for a period of twenty-one years, contains the record of some important changes which have taken place in the management of the journal during the past twelve months. Four quarterly numbers of the journal were issued during the year. The first informed us that the journal had become, by purchase, the property of the Conchological Society, and would be continued as the official organ of that Society, under the editorship of Mr. W. E. Hoyle. All four numbers contain original papers of varied character and interest, accompanied in some cases by good lithographic or photographic plates of illustrations; and the Proceedings of the Conchological Society, as published in the journal, alone furnish an interesting record of valuable observations in many departments of malacology. The annual report of the Conchological Society for 1894–5 is contained in the July number. From it we learn that all arrangements have been made for the transfer of the headquarters of the Society from Leeds to Manchester, with branches in Leeds and London—a change which, it may be hoped, will contribute still further to the growth and vigour of the Society.

SEVERAL novel scientific instruments and devices described in the new catalogues of scientific apparatus and of lanterns and slides, recently issued by Messrs. Newton and Co., deserve mention here. A very simple method devised to show stereoscopic pictures with the optical lantern is especially noteworthy. A pair of negatives is taken with a stereoscopic camera, and a lantern slide is made from each. One of these slides is mounted in contact with a bluish-green glass, and the other in contact with a red glass. The two slides are simultaneously projected upon a screen, by means of two lanterns, but are not exactly superimposed. The combined picture is then viewed through spectacles, the glasses of which are of the same kind as those covering the slides. Only the red picture is seen through the red glass, and only the bluish-green picture with the bluish-green glass. And as the two pictures are from stereoscopic negatives, a definite stereoscopic effect is produced by making each eye only see one of the pair of pictures, the combination of both of which gives the effect of relief. An advantage which this method possesses is that it can be used with any pair of lanterns. All that is required is stereoscopic slides mounted with suitably coloured glasses, and similarly coloured spectacles through which the pictures must be viewed. Under these conditions, the pictures stand out in strong stereoscopic relief upon the screen. Among the many new forms of instruments described, we notice a new sunshine

recorder, and several improved forms of electric lamps for lanterns. The catalogue of lantern slides should be seen by all who use the lantern in science lectures. It includes Prof. Boys' photographs of "flying bullets," sixty-three slides illustrating volcanic action, from photographs by Prof. Johnston Lavis; photo-micrographs of rock-sections, and many other subjects. The slides are so numerous, and cover so wide a range, that teachers of any and every branch of science will find some in which they will be specially interested.

WE have on our table a number of new editions of books already reviewed in NATURE. One of these is the second edition of the "Lehrbuch der Botanik" (Jena: Gustav Fischer), by Drs. Strasburger, Noll, Schenck, and Schimper. This important work was first published in 1894, and the quick call for a second edition shows that botanists have not been long in finding out its admirable qualities. Dr. Oscar Hertwig's classic "Lehrbuch der Entwicklungsgeschichte" (Gustav Fischer) has now reached its fifth German edition. A number of new figures has been added, and results obtained by embryologists in the two years that have elapsed since the publication of the fourth edition have been incorporated in the text. Another fifth edition recently received is "Dynamo-Electric Machinery" (E. and F. N. Spon), by Prof. S. P. Thompson, F.R.S. The chief changes that have been made relate to alternate-current machinery. These and other additions have been made necessary by the development of electric machinery since 1892, when the fourth edition of Prof. Thompson's elaborate work appeared. A second edition has been published of "Dynamo Attendants and their Dynamos" (*Electricity* Office), by Mr. A. H. Gibbings. The book is intended for those practical men who have charge of electric lighting plant without knowing much about electrical principles; it consists, therefore, mainly of hints and advice as to how to manage dynamos, and what to do under those perplexing circumstances which occur in the best regulated dynamo rooms. After six years, a second edition has been published of "Service Chemistry" (W. B. Whittingham and Co.), by Prof. Vivian B. Lewes. The volume is primarily intended to be an exposition of the applications of chemistry in the naval and military services; nevertheless, a fair proportion of its space is taken up with descriptions of the general principles upon which all technical chemistry depends. Messrs. W. Collins, Sons, and Co. have issued a new edition of "A Manual of Inorganic Chemistry," by Prof. T. E. Thorpe, F.R.S. Since this manual was first published, twenty-three years ago, it has been frequently reprinted, but the new edition contains so much new matter, and is so greatly altered, that it is practically a new text-book, which will be found even more serviceable than the original one. The work is published in two volumes, which deal, respectively, with the non-metals and metals; it has been brought thoroughly up to date, and well records the present state of knowledge of the chemistry of the mineral kingdom.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*, ♂ ♂) from India, presented by Mr. F. Greswolde Williams; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Captain Pickthorn; four Pratincoles (*Glareola pratincola*), four Marbled Ducks (*Anas marmorata*), South European, presented by Lord Lilford; a Snow Bunting (*Plectrophanes nivalis*), European, presented by Mr. J. E. Harting; two Passerine-Parrakeets (*Psittacula passerina*) from Brazil, presented by Mrs. Robert McCabe; a Ring-necked Parrakeet (*Palæornis torquata*) from India, presented by Mr. E. Parrott; a Leadbeaters Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. B. T. Frere; two Leopard Tortoises (*Testudo pardalis*), two Puff Adders (*Vipera arietans*), an Infernal Snake (*Sepedon hæmachates*) from South Africa, presented by Mr. J. E. Matcham; a Manatee (*Manatus australis*) from Demerara, presented by Captain Edward J. Collings; a Southern River Hog (*Potamochœrus africanus*) from South Africa, presented by Mr. W. Anthony Morgan; a Black-handed Spider Monkey (*Ateles geoffroyi*) from Central America, a —— Terrapin (*Hydromedusa tectifera*) from Rio de la Plata, purchased.

OUR ASTRONOMICAL COLUMN.

CELESTIAL PHOTOGRAPHY BY SIMPLE MEANS.—In the hands of Prof. Barnard, the "magic lantern" lens has developed into an instrument of considerable astronomical importance. The lens actually employed by him is a $1\frac{1}{2}$ inch doublet of 4 or 5 inches equivalent focus, and the scale of the pictures is roughly 10° to an inch. Six beautiful photographs of various parts of the Milky Way taken with this small optical aid are reproduced in the *Astrophysical Journal*, vol. ii. No. 5, and they admirably illustrate the value of such an instrument in the delineation of extended nebulosities and in photographing large areas of the sky. They are selected from the more remarkable parts of the Milky Way, but Prof. Barnard has obtained a great number of such photographs, and proposes soon to construct a photographic chart from them. The picture of the new nebulous region in Scorpio shows two very obvious streams or "dark lanes" which are almost void of stars, and various peculiarities are presented by the other photographs.

In the same journal there is a reproduction and an account of a very fine photograph of the nebula near ξ Persei (N.G.C. 1499) taken with an exposure of six hours by means of the 6-inch Willard telescope, at the Lick Observatory, on September 21, 1895. The nebula is very irregular with numerous condensations, and is remarkable for a small dark spot, about 6′ in diameter, in its northern part; "doubtless a hole in the nebula," says Prof. Barnard. Attention is drawn to the suggestive fact that this nebula lies on the edge of a region in which there is a comparative absence of small stars, as noticed also in the case of most of the large diffused nebulæ lately photographed.

THE CONSTANT OF NUTATION.—A new determination of the constant of nutation has been made by Dr. Chandler (*Astronomical Journal*, No. 361). It is based on a discussion of 20,294 observations of stars with the mural circles of Troughton and Jones at Greenwich during the years 1825–1848. In order to eliminate errors due to possible slow changes of the angle between the pole and the zenith, whether strictly or irregularly systematic, it has been considered necessary to employ a large number of stars, distributed as uniformly as possible over the entire sky; and the Greenwich observations offer this facility, while at the same time possessing the necessary degree of accuracy. The adopted mean value of the latitude of Greenwich is 51° 28′ 38″·42, and assuming that this is the same in all years, the nutation is found to be 9″·197, after eliminating the short-period terms of the latitude variation. This assumption, however, is not justified, as the observations indicate a pronounced deviation, which cannot be explained by anomalies of refraction, but must be due to a change in the place of the zenith. Although such a change may possibly be subjective, Dr. Chandler thinks it much more likely to be due to an actual slow change of the latitude. The observations favour an inequality of the mean latitude with a period of about twelve years, and a range of about a quarter of a second. To whatever cause this change may ultimately be ascribed, it is at least necessary to take account of it in evaluating the constant of nutation; and when this and all other corrections have been applied, the definitive value of the nutation, from the observations with the Greenwich mural circles, is 9″·192 ± 0″·012. Combining this result with all previous ones which are entitled to any weight at all, the final value becomes 9″·202. The corresponding reciprocal of the moon's mass, in terms of that of the earth, is 81·80, if 50″·36 be taken for the luni-solar precession.

A YORKSHIRE AEROLITE.

FOLLOWING my recent description of the "Yorkshire Gypsey-Springs," I may say that the great Yorkshire aerolite fell a century ago at the village of Wold Newton, where these springs first rise to light. Wold Newton is ten miles west from Bridlington Quay, no village on the Yorkshire Wolds having so much to interest the students of archæology and natural phenomena. Here, at Wold Cottage, lived Edward Topham, the retired "Tip-top Adjutant," who, in 1787, established *The World*, and whose epilogue, spoken by Lee Lewis in the character of Molière's "Old Woman," created him a star in the dramatic firmament. Two fields south-westerly from Wold Cottage, and protected on the north side by a plantation, you come to a flue-like column of bricks, which used to receive its washing with white lime every year. A yellow slab in the middle bears the following inscription :—

HERE,
on this spot, December 13th, 1795,
fell from the atmosphere
AN EXTRAORDINARY STONE.
In breadth 28 inches,
In length 30 inches,
and
whose weight was 56 pounds.
This column
was erected by
Edward Topham,
1799.

Thus, it is scarcely more than a century since this meteoric stone fell. The day was Sunday, the time about three o'clock in the afternoon, the weather misty, thunder and lightning being at a distance. Suddenly there came a noise like an explosion. George Sawden, a carpenter, was passing within sixty yards of the spot where the aerolite fell; and so much nearer was John Shipley, a farm servant, that he was struck by some soft earth thrown up by the stone when it plunged into the earth. While it was still passing in a north-easterly direction from the sea-coast, a number of persons at Reighton, who, while "turniping" their sheep in the fields, saw it moving down the clouds, made hasty steps for the top of their church-tower to see where it fell, while others spread the tale that it was a cannon-ball shot by a ship-load of French giants who were supposed to have landed to invade the island. Two sons of the Vicar of Wold Newton heard the same body whizz over their heads, and they were among the first on the spot where it fell. It excavated a place 19 inches deep and of something more than 3 feet in diameter, embedding itself so fast in the chalk rock that considerable force was required to dislodge it. A piece split off was, sixty years ago, in the possession of the Rev. Francis Wrangham, F.R.S., Vicar of Hunmanby. It had a black, vitrified surface, and exhibited marks of having been exposed to the action of fire. The inside was white and of a granulated but very compact texture, its composition having no resemblance to any natural stone of the terrestrial sphere. Sent originally to Sowerby's Museum, London, now the aerolite occupies a conspicuous position in the British Museum. It is about the size of a man's head.

HARWOOD BRIERLEY.

PRIZE SUBJECTS OF THE PARIS ACADEMY OF SCIENCES.

AT the recent annual meeting of the Paris Academy of Sciences, the following prizes were announced for the year 1896. In Mathematics the subjects proposed are: the Grand prize for an important improvement in the algebraic theory of groups of substitutions between *n* letters; the Bordin prize (3000 fr.) for an important advance in the theory of geodesic lines; the Francœur prize (1000 fr.) and the Poncelet prize (2000 fr.) will be awarded for discoveries useful in pure and applied mathematics. In Mechanics, the extraordinary prize of 6000 fr. will be given as a reward for an invention tending to increase the efficiency of the French naval forces, the Montyon for the improvement or invention of instruments useful to the progress of agriculture or the mechanical arts, and the Plumey prize (2500 fr.) for improvements in steam engines or any invention contributing to the progress of steam navigation.

In Astronomy, the Lalande prize (540 fr.) wi be awarded to any one (in France or elsewhere) who shall ha\ - made the most interesting observation, or have published the most useful work bearing on astronomy; the conditions for the Valz prize (460 fr.) are similar. The subject announced for the Damoiseau prize (1500 fr.) is to connect together by the theory of disturbances the various appearances of Halley's comet, going back as far as 1456 (Toscanelli), taking account of the attraction of Neptune, and also to calculate exactly the next return in 1910. The Janssen prize (a gold medal) is offered for an important result in Physical Astronomy; a Montyon prize (500 fr.) for studies in French statistics, and the Jecker prize (10,000 fr.) for researches in organic chemistry. In Mineralogy and Geology, the subjects for the Vaillant prize (4000 fr.) are to study the physical and chemical causes which determine the existence of rotatory power in transparent substances, especially from an experimental point of view, and to improve, theoretically or practically, methods relating to geodesy or topography; the Fontannes prize (2000 fr.) is offered for contributions to palæontology.

In Botany, there will be awarded the Demazières prize (1600 fr.) for the best contribution, to our knowledge of the Cryptogamia, the Barbier prize (2000 fr.) for a botanical discovery having special reference to medicine, two Montagne prizes (1000 fr. and 500 fr.) for work bearing on the anatomy, physiology, development, or description of the lower Cryptogams, and the Thore prize (200 fr.) for the best memoir on European cellular Cryptogams. In Anatomy and Zoology, the Savigny prize (975 fr.) is given to aid young travellers, who, not receiving Government assistance, specially occupy themselves with the Syrian and Egyptian invertebrates. One or more Montyon prizes will be awarded for discoveries in Medicine and Surgery, the Bréant prize (100,000 fr.) for a specific cure for Asiatic cholera. Other prizes offered in Medicine are the Godard prize (1000 fr.) for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs, the Serres prize (7500 fr.) for the best work on general embryology applied to physiology and medicine, the Bellion prize (1400 fr.) for work of especial value to the public health, the Mège prize (10,000 fr.) for an essay on the causes which have helped or retarded the progress of medicine, and the Lallemand prize (1800 fr.) for researches on the nervous system. In Physiology, besides a Montyon prize (750 fr.), there is offered the Philipeaux prize (890 fr.) for experimental physiology, and the Pourat prize (1800 fr.).

In Physical Geography, the subject announced for the Gay prize (2500 fr.) is a study of the French lakes from a chemical, physical, and geological point of view. Besides the Arago medal, which is only occasionally awarded for discoveries of special value, the following general prizes are offered for 1896. The Montyon prize (unhealthy trades) for a means of rendering less dangerous an unhealthy trade, the Trémont prize (1100 fr.) the Gegner prize (4000 fr.), the Delalande-Guérineau prize (1000 fr.), the Jean Reynard prize (10,000 fr.), the Jérome Ponti prize (3500 fr.), the Tchihatchef prize (3000 fr.) for the exploration of imperfectly known regions of Asia, the Houllevigue prize (5000 fr.), the Cahours prize (3000 fr.) for the encouragement of young men already known as having done interesting work, especially in chemistry, the Saintour prize (3000 fr.), the Laplace prize of books, and the Rivot prize (2500 fr.).

In the case of the prizes bearing the names of La Caze, Delesse, Desmazières, Lalande, and Leconte (in 1898), it is specially stated that they are awarded entirely without preference of nationality, and of the remainder only two or three are restricted to French subjects. All memoirs for this year must be sent in to the Academy before June 1.

AMATEUR CLOUD PHOTOGRAPHY.[1]

THE blue colour of the sky has as much action on an ordinary sensitive plate as the white colour of light clouds (cirrus and cirro-cumulus); it is therefore necessary to diminish the action of the blue background of the sky. For this purpose a yellow screen is placed so as to intercept the rays; the light coming from the sky contains very few yellow and green rays, and is thus extinguished to a great extent; but, on the other hand, the great proportion of yellow and green rays which exists in the white light of the clouds passes the screen and makes an impression on the plate, if it has been made more sensitive to the action of yellow and green rays than the ordinary plates.

There are, therefore, three points to be considered: (1) the coloured screen; (2) the sensitive plate; (3) the method of development of the images.

(1) *The Coloured Screens.*—Coloured screens formed of films of

[1] By M. Angot. (Translated from *Cosmos*, November 23, 1895.)

gelatine or collodion must be rejected, because their tint changes very quickly in the light, and they easily lose their transparency. Either yellow glass must be used, or cells containing a suitable liquid.

Yellow glasses make the most convenient screens of all; but the difficulty is to find suitable glasses which are always the same, and of sufficiently graduated shade. Some are excellent, others not worth anything. Before recommending the use of coloured glasses exclusively, some experiments ought to be made with the help of a glass maker, in order to ascertain what ought to be the exact composition of the glass so that it may be reproduced with the exact tone at any time. It is unnecessary to add that the glass must be homogeneous and polished with quite parallel surfaces; only glass ought to be used which is coloured in mass, and not white covered with a superficial layer of enamel.

The surest method, in the case of not being able to get glass of which the composition is known, would be to use liquid screens, as I do. They are made with two parallel square glasses cemented together on three sides by square glass rods also with parallel sides, and with a thickness of six or seven millimetres, and length of side seven to eight centimetres, one side remaining open. If one does not wish to go to the trouble of making them, these cells can be obtained from instrument-makers. Needless to say that before cementing, the glasses must be carefully cleaned with a solution of carbonate of soda, then with water, and lastly by being well rubbed with a piece of cotton-wool dipped in alcohol; with these precautions, no air is to be feared along the sides of the cells. Before introducing the liquid, care must be taken to dip the open end of the cell in a bath of resin (a mixture of yellow wax and resin of equal parts). For ultimately closing the cell, it suffices to fasten on the edges, thus covered with resin, a little plate of glass cut to a suitable size, and which must be heated on a plate of copper to prevent its breaking. If found desirable the aperture may be still more securely closed with sealing-wax. Thus cells are obtained hermetically sealed, which can be used at every inclination without the liquid spilling and without air getting along the joints.

The easiest way of fixing these cells in position is to pierce a circular hole in the centre of a flat piece of cork, the size of the sunshade of the lens of the camera. The plate is fitted into the sunshade and held by india-rubber. The screen is thus in front of the lens, and it can be easily replaced by others more or less dark.

For the liquid, I have had to reject all solutions of organic colours, such as aurentia, primuline, chrysoidine, for they alter in the light. The simplest one is to use the bichromate of potash. A saturated solution is prepared at ordinary temperature, to which is added, after straining, a few drops of hydrochloric acid. This saturated solution, introduced into one of the previously described cells, constitutes screen (1), which should be used when the clouds are very light, and the sky of a pale blue. A solution of half the strength forms screen (2), which may be used for well-lighted detached cirrus on a really blue sky; lastly, screen (3), consisting of one part of the saturated solution to three of water, should be reserved for very luminous clouds as cumulus and cumulo-nimbus.

It is certainly more convenient and more simple to use coloured glasses as screens; but while there is a doubt as to finding suitable glass, we can always be certain when using bichromate cells of straightway obtaining excellent screens, always precisely the same. The ones I possess have been in use two years, and no precautions have been taken to preserve them.

(2) *Sensitive Plates.*—Special plates must be used for yellow light. The way of preparing these plates by means of ordinary plates is already well known; I did this at first. But I am certain that the necessity of preparing the plates is the principal obstacle which stops people taking photographs of clouds, who are really desirous of doing so. However, prepared plates are to be had in the trade, and they serve the purpose admirably.

Among the types of plates called orthocromatic or isochromatic, two have given me excellent results: Lumière's orthochromatic plates, sensitive to yellow and green light, and Edward's orthochromatic plates.

There is, therefore, no necessity to prepare plates, as they are to be had ready-made, and, at least in most cases, quite as good as those one could prepare personally. It has been said that the sensitiveness of these plates alters very soon, so much so that they are useless at the end of a few months. With regard to this, I can but quote the following fact. In February 1893, I received from the firm of Lumière, three boxes of orthochromatic plates, of which the date of manufacture is unknown to me. These three boxes were simply placed in a cupboard of my bureau without any other precautions. The first box of twelve plates was used in the course of 1893; the second, only opened at the beginning of 1894, and used between the months of March and November; lastly, the third box was opened only in November 1894, and the two first plates gave negatives which did not differ at all from those obtained from similar plates twenty months before.

Other similar boxes opened, then forgotten, for some months in a cupboard, have always given me excellent results.

I intend to continue these studies; but it seems to me now established, that if the sensitiveness of these plates diminishes with time, this diminution is small enough to permit of the plates being used after more than eighteen months. Under these conditions nothing can be said against their use.

Focussing is done without any difficulty on a distant object, for instance on a house in bright light. If the horizon is not far enough distant, an object can be taken comparatively near (at least twenty-five or thirty metres), then in order that the position shall correspond with infinity, move the ground-glass towards the lens a distance $\frac{f}{k-1}$, f being the focal distance of the lens, and k the number of times that the distance of the object which has been focussed contains the focal length of the lens. For instance, if an object twenty metres distant has been focussed with a lens, of which the focal length is twenty-five centimetres, then we get $k = \frac{2000}{25} = 80$. In order that the clouds may be in focus, the ground-glass must be brought a distance of $\frac{25}{79} = 0{\cdot}32$ c.m., about 3 millimetres, nearer the lens. Of course the focus must be got with the coloured screen, and the position thus found must be marked on the base of the camera, in order that the position of the frame may be known.

(3) *Development.*—No mode of development must be rejected *à priori*; even developers called *automatic*, which can be bought ready prepared. and which have been very much run down, for they are by far the most convenient, and often give excellent results.

If the negative that we wish to develop contains only clouds of more or less the same intensity, the automatic developers may be used without any risk. I have used baths of hydroquinone, Lumière's developer (of paramidophenol), &c., with success. It is advantageous to use baths which have already been used, and consequently containing a good proportion of bromide; a greater contrast is then obtained between the clouds and sky, and the development can be carried further without fear of fogging.

If, on the contrary, the negative consists of clouds of very unequal luminous intensity, as, for instance, delicate cirrus and strongly lighted cumulus, the negative would not turn out well with automatic developers containing much bromide; the image of the cumulus would appear, and be over-developed before that of the cirrus had begun to show itself. In this case either a new bath must be used, very diluted, without bromide, and the development is then very slow, or else (which is preferable) use pyrogallic acid, in employing the method recommended by M. Londe. In this case the development must be commenced with a very small quantity of pyrogallic acid, a little bromide, and relatively enough carbonate of soda, in such a way as to make all the parts of the image appear at first, without much intensity; then the necessary intensity will be obtained little by little, by the successive additions of pyrogallic acid. It is in this case only, where the intensity of the clouds is very different, that I think it advantageous to recommend progressive development instead of pyrogallic acid. In most ordinary cases, however, the automatic developers, which are more rapid, and more convenient to use, act very well.

In fact it is always as well to continue the development till the image is sufficiently dense, without intensifying, which is almost always possible. Negatives ought only very exceptionally to be intensified; to my mind, the intensification is always bad, it spoils the detail; a renewed or feeble negative is never worth as much as one that was made sufficiently dense in the first instance.

If I have gone into all these details, it is only to show that photography of clouds is a very easy operation, and within the reach of all amateurs. And let me just add, that with the darkest screen (saturated bichromate) and Prazmowski's lens, with a focus of 160 millimetres, and diaphragm of $\frac{1}{30}$, I obtain negatives with a maximum exposure of six seconds for cirrus, with an ordinary amount of light with a Zeiss' object-glass, a diaphragm of $\frac{1}{15}$ and very bright cirrus, having an exposure of $\frac{1}{30}$ of a second, has sometimes been more than sufficient, even too much.

It would be very interesting if amateurs in photography, so numerous at the present time, would try to photograph clouds which strike them as having interesting shapes, noting with care the hour when they were taken, and also the direction in which the clouds appeared.

SCIENCE IN THE MAGAZINES.

ONE of the most interesting contributions to this month's magazines is an illustrated account in the *Century* by Mr. Borchgrevink, of his voyage in the *Antarctic*, prefaced by a note by Mr. A. W. Greely. The article will give an impulse to the movement in favour of an expedition to explore the Antarctic continent. Referring to Mr. Borchgrevink's account, Mr. Greely says: "From a scientific standpoint the interest depends entirely upon the discovery by Borchgrevink, on Possession Island and Cape Adare, Victoria Land, of a cryptogamous growth, probably an unidentified lichen. The importance of this discovery rests in the fact that hitherto no land vegetation of any kind or description had been found within the confines of the Antarctic circle. The strained deduction has been drawn that the climatic conditions of the Antarctic zone must have changed since the voyage of Ross, who discovered no vegetation. It should be borne in mind, however, that the great botanist, Sir Joseph Hooker, who served with Ross, was unfortunately prevented from landing with his commander; otherwise it may not be doubted that low forms of vegetable life which escaped the attention of Ross would have been noted by Hooker. In a practical way it emphasises the possibility of much more extended exploration in the Antarctic Ocean, through the agency of the steam-power of to-day, than was practicable for the greatest of Antarctic navigators—Cook, Balleny, Weddell, Wilkes, and Ross—under sail alone in the past." Ethnologists will be interested in the studies of Indian life given by Alice C. Fletcher in the *Century*, under the title "Tribal Life among the Omahas."

An illustrated description of the magnificent new building of the Boston Public Library, contributed by Mr. T. R. Sullivan to *Scribner*, shows how very thoroughly the American people are working for the advancement of learning. The building will hold a million and a quarter volumes, and everything has been done to make it beautiful, while all that modern contrivance can offer has been utilised to secure comfort. "The reference reading-room of the library," we read, "and its seven thousand volumes are free to all who care to take them down, without the intervention of an attendant. At the southern end, always open for consultation, is the card-catalogue of all the books contained in the building; any one of these will be furnished and brought from the main library to the designated table at a few moments' notice. There is room for hundreds of readers to sit here from early morning to a late hour of the night in undisturbed pursuit of knowledge. Those who have tried to work in the overcrowded libraries of Europe, hampered by annoying restrictions and wearisome delays, will fully comprehend the blessing which such freedom brings." In the same magazine there is an article on "Water-ways, from the Ocean to the Lakes," by Mr. T. C. Clarke, dealing chiefly with the great canal from Lake Erie to the Hudson River. In the editorial notes, reference is made to recent gains in the speed of travel. It appears that the distance between Buffalo and Chicago—512 miles—has been covered at a rate of over sixty-five miles per hour, stops excluded. The distance between New York and Washington is now done in about five hours, but a railway exists (on paper) the trains of which are to shoot over this distance of 240 miles in two hours! The track is to be elevated above the ground on a single line of upright piers, and the trains are to be driven by electricity, each car carrying its own motor machinery. The most distinctive mechanical feature of the enterprise is the so-called "bicycle" arrangement, by which a single line of wheels run on single rail. The train is to be kept upright by an auxiliary rail on each side, which will not, however, come into play except in rounding curves.

In the *Popular Science Monthly* Prof. G. F. Wright discusses the "New Evidence of Glacial Man in Ohio," afforded by a small chipped chest implement found by a trustworthy observer close to Brilliant Station on the Ohio River. He concludes that the discovery "must go far to close the question of man's antiquity on the Western continent, and to dispel the doubts upon the subject which, for one reason or another, have heretofore existed." Prof. James Sully continues, in the same magazine, his "Studies of Childhood," and among the other articles are "The Anatomy of Speed Skating," by Mr. R. Tait McKenzie; a criticism by Mr. Le Sueur of Prof. Forbes' article on the work of the Cataract Construction Company, published in *Blackwood's Magazine* for September 1895; "Health Experiments in the French Army," by Mr. Stoddard Dewey; and "Prehistoric Engineering at Lake Copais," by Mr. J. D. Champlin.

Mr. W. H. Mallock continues in the *Contemporary* his essay on "Physics and Sociology." He holds that the struggle which causes social progress is a struggle of the few against the few, and is fundamentally different from the Darwinian struggle for existence. In his words: "Within the limits of the minority, composed of the exceptionally gifted, whether their gifts are those of scientific knowledge, or knowledge of men's characters and wants, or of a power to direct men, there does undoubtedly take place a struggle strictly analogous to that with which Darwinian science has familiarised us, the result being, as Mr. Spencer's celebrated formula expresses it, the survival of the fittest. Only it is not a struggle for existence, if the word existence is taken to mean life; it is a struggle for existence in a position of rule or domination. It is, moreover, not a struggle with the majority of the community, but with the minority only. The fittest, the survivors, the winners, instead of depriving the majority of the means of subsistence, on the contrary, increase those means, and their unsuccessful rivals are defeated, not by being deprived of the means of living, but only of the profits and privileges that come from directing others. That there is a subsidiary struggle amongst the majority, a struggle to obtain work, not to direct work, is true, as has been said already; but, as has been said also, this is not the struggle which primarily either causes the advance of civilisation or maintains such advances as have been made. It contributes to these results, and how far and in what way it does so will require to be discussed hereafter; but it is not the principal, it is not the primary cause of them. The primary cause is the struggle which causes the survival, not of the largest number of men of average capacity, but of the largest number of men of exceptional capacity—the largest number of great men." Thus, according to the argument, the *domination* of the fittest is the true counterpart in the social world of the *survival* of the fittest in the physiological world. The *Contemporary* also contains a short paper by Mr. Herbert Spencer, on the development of the architect, the paper being the ninth of a series on "Professional Institutions." The view is taken that "the earliest architecture bequeathed by ancient nations was an outcome of ancestor-worship."

In *Science Progress*, Dr. H. E. Armstrong describes "The Plan of Research in Education," and makes a powerful plea for scientific teaching and scientific research, both on account of education and industrial progress. Prof. F. O. Bower discusses recent work on mosses and ferns, with special reference to Prof. Campbell's volume on the subject; Mr. J. W. Rodger continues his statement of "The New Theory of Solutions"; Mr. Philip Lake describes "The Geology of Egypt"; and Mr. G. T. Holloway traces "The Evolution of the Thermometer."

A brief mention will suffice for the remaining articles in the magazines received by us. *Good Words* has a short illustrated paper on sponges, by the Rev. T. Bird, and one on "A School of Mackerel," by Mr. Edward Step. The *Strand Magazine* has several splendid reproductions from photographs of frost patterns on window-panes, obtained by Mr. James Leadbeater. The *Phonographic Quarterly Review* always contains two or three scientific articles. The current number has in it "In a Canadian Forest," by General Sir Charles Wilson, K.C.B., F.R.S. "St. Bartholomew and his Hospital," by Dr. W. R. Gowers, F.R.S., and several other articles of interest to scientific phonographers. The *Fortnightly* has an article on "The Climate of South Africa," by Dr. R. Roose; and among the information articles in

Chambers's we notice one descriptive of the Loofah, or Luffa, by Prof. Carmody.

We have received, in addition to the magazines and reviews named in the foregoing, the *Humanitarian*, *Sunday Magazine*, *National*, *English Illustrated*, and *Longman's*, but the articles in them do not call for particular comment in these columns.

RECENT PROGRESS IN OPTICS.[1]

THE reviewer who aspires to give an account of recent progress in any department of science, is met at the outset by two causes for embarrassment. What beginning shall be selected for developments called recent? What developments shall be selected for discussion from the mass of investigations to which his attention has been called? So rapidly is the army of workers increasing, and so numerous are the journals in which their work is recorded, that the effort to keep up with even half of them is hopeless; or, to borrow a simile employed by the late Prof. Huxley, "we are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her."

I have selected a single branch of physics, but one which can scarcely be treated rigorously as single. From the physical standpoint optics includes those phenomena which are presented by ether vibrations within such narrow limits of wave-length as can affect the sense of sight. But these waves can scarcely be studied except in connection with those of shorter and of longer period. Whatever may be the instruments employed, the last one of the series through which information is carried to the brain is the eye. The physicist may fall into error by faulty use of his mathematics: but faulty use of the senses is a danger at least equally frequent. Physiological optics has of late become transferred in large measure to the domain of the psychologist; but he in turn has adopted many of the instruments, as well as the methods, of the physicist. The two cannot afford to part company. If I feel particularly friendly to the psychologist, more so than can be accounted for by devotion to pure physics, it may be fair to plead the influence of old association. If I am known at all in the scientific world, the introduction was accomplished through the medium of physiological optics. But, with the limitations imposed, it is not possible even to do justice to all who have done good work in optics. If prominence is assigned to the work of Americans, it is not necessary to emphasise that this Association is made up of Americans; but, with full recognition of the greater spread of devotion to pure science in Europe, of the extreme utilitarian spirit that causes the value of nearly every piece of work in America to be measured in dollars, we are still able to present work that has challenged the admiration of Europe, that has brought European medals to American hands, that has been done with absolute disregard of monetary standards; work has been recognised, even more in Europe than in America, as producing definite and important additions to the sum of human knowledge.

In drawing attention to some of this work it will be a pleasant duty to recognise also some that has been done beyond the Atlantic—to remember that science is cosmopolitan. The starting-point is necessarily arbitrary, for an investigation may last many years and yet be incomplete. To note recent progress, it may be important to recall what is no longer recent.

Light Waves as Standards of Length.

You are therefore invited to recall the subject of an address to which we listened in this section at the Cleveland meeting in 1888, when Michelson presented his "Plea for Light Waves." In this he described the interferential comparer, an instrument developed from the refractometer of Jamin and Mascart, and discussed various problems which seemed capable of solution by its use. In conjunction with Morley he had already used it in an inquiry as to the relative motion of the earth and the luminiferous ether (*American Journal of Science*, May 1886, p. 377), and these two physicists together worked out an elaborate series of preliminary experiments (*ibid.*, December 1877, p. 427) with a view to the standardising of a metric unit of length in terms of the wave-length of sodium light. By use of a Rowland diffraction grating, Bell had determined the sodium wave-length with an error estimated to be not in excess of one part in two hundred thousand (*American Journal of Science*, March 1887, p. 167). Could this degree of accuracy be surpassed? If so, it must be not so much by increased care in measurement as by increase of delicacy in the means employed. The principle applied in the use of the interferential comparer is simple enough; the mode of application cannot be clearly indicated without a diagram, but probably all physicists have seen this diagram, for it was first brought out eight years ago (*ibid.*, December 1887, p. 427). By interference of beams of light, reflected and transmitted by a plate of plane parallel optical glass, and then reflected back by two mirrors appropriately placed, fringes are caught in an observing telescope. One of the mirrors is movable in front of a micrometer screw, whose motion causes these fringes to move across the telescopic field. If the light be absolutely homogeneous, the determination consists in measurement of the distance through which the movable mirror is pushed parallel to itself and the counting of the number of fringes which pass a given point in the field of view. According to the theory of interference the difference of path between the distances from one face of the plate to the two mirrors should be small; beyond a certain limit interference phenomena vanish, and this limit is smaller in proportion as the light is more complex. In the case of approximately homogeneous light there are periodic variations of distinctness in the fringes. For example, assume sodium light, which in the spectroscope is manifested as a pair of yellow lines near together. In the refractometer there are two sets of interference fringes, one due to each of the two slightly different wave-lengths. When the difference of path is very small, or nearly the same for both of these radiation systems, the fringes coincide. The wave-length for one is about one-thousandth less than that for the other. If the difference of path is about five hundred waves, the maximum of brightness for one system falls on a minimum of brightness for the other, and the fringes become faint. They become again bright when the difference of path reaches a thousand wave-lengths. The case is entirely similar to the familiar production of beats by a pair of slightly mistuned forks.

The method of interference thus furnishes through optical beats a means of detecting radiation differences too minute for resolution by ordinary spectroscopic methods. Spectrum lines are found to be double or multiple when all other means of resolving them fail; and the difficulty of attaining truly homogeneous light is far greater than was a few years ago supposed. By the new method it becomes possible to map out the relative intensities of the components of a multiple line, their distance apart, and even the variations of intensity within what has for convenience been called a single component. Each of the two sodium lines is itself a double whose components are separated by an interval about one-hundredth of that between the long-known main components; and an interval yet less than one-fifth of this has been detected between some of the components of the green line of mercury. Indeed Michelson deems it quite possible to detect a variation of wave-length corresponding to as little as one ten-thousandth of the interval between the two main sodium lines (*Astronomy and Astrophysics*, p. 100, February 1894.)

This new-found complexity of radiation, previously thought to be approximately if not quite simple, proved to be a temporary barrier to the accomplishment of the plan of using a light-wave as a standard of length. It necessitated careful study of all those chemical elements which give bright lines that had been supposed to be simple. The red line of cadmium has been found the simplest of all those yet examined. The vapour in a rarefied state is held in a vacuum tube through which the electric spark is passed, and under this condition the difference of path for the interfering beams in the refractometer may be a number of centimetres. A short intermediate standard, furnished with a mirror at each end, is now introduced into the comparer, and moved by means of the micrometer screw. Its length is thus measured in terms of the cadmium wave-length. A series of intermediate standards, of which the second is double the first, the third double the second, &c., are thus compared, and finally in this way the value of the metre is reached.

The feasibility of this ingenious method having been made apparent, Michelson was honoured with an invitation from the International Bureau of Weights and Measures to carry out the measurement at the observatory near Paris, with the collaboration of the director M. Benoît. After many months of labour, results of extraordinary accuracy were attained. For the red line of

[1] Address delivered by Prof. W. LeConte Stevens before the Section of Physics of the American Association for the Advancement of Science, at the Springfield meeting, August 1895.

cadmium at an air temperature of 15° C. and pressure of 760 mm., two wholly independent determinations were made. From the first a metre was found equal to 1553162·7 wave-lengths; from the second, 1553164·3 wave-lengths, giving a mean of 1553163·5 the deviation of each result from the mean being very nearly one part in two millions ("Travaux et Mémoires du Bureau Internationale des Poids et Mésures," Tome xi. p. 84, 1894). A determination by Benoît from the first series gave 1553163·6, which differs but one-tenth of a wave-length from the mean of Michelson's measurements.

The direct comparison of the lengths of two metre bars, though not easy, is a simple operation in comparison with the indirect method just described, but does not surpass it in accuracy. Every one knows that the metre is not an exact submultiple of the earth's circumference, and that the determination of its exact value from the seconds pendulum is full of difficulty. It may perhaps be said that the optical method is no more absolute than the pendulum method, for no human measurements can be free from error; that there is no possibility of the destruction of the original metre and all certified copies of it; and that there is no proof or probability that molecular changes are gradually producing modifications in standards of length. Even if we should grant that for all practical purposes the labour of determining the metre in terms of an unchanging optical standard has been unnecessary, the achievement is a signal scientific triumph that ranks with the brilliant work of Arago, Fresnel and Regnault. In preparation for it much new truth has been elicited, and light waves have been shown to carry possibilities of application that Fresnel never suspected.

The physicist is nearly powerless without the aid of those who possess the highest order of mechanical skill. The interferential comparer could never have been ultilised for such work as Michelson has done with it, had not Brashear made its optical parts with such an approach to perfection that no error so great as one-twentieth of a wave-length could be found upon the reflecting surfaces ("Travaux et Mémoires du Bureau Internationale des Poids et Mésures," Tome xi. p. 5, 1895). In the conception, mechanical design and execution, the entire work has been distinctly American.

The interferential refractometer has been used with much skill by Hallwachs (*Wiedemann's Annalen*, Band 47, p. 380, and Band 53, p. 1) for comparing the variation of refractive index of dilute solutions with variation of concentration. The fact of solution brings about a change of molecular constitution, affecting both the electric conductivity and the refractive index; and the changes in optical density are measurable in terms of the number of interference fringes which cross the field of view for a given variation of dilution.

LUMINESCENCE.

While all work on the visible spectrum is confessedly optical, we can no longer make an arbitrary division point, and declare that one part of the spectrum belongs to the domain of optics and the other not. Since the days of Brewster and the elder Becquerel fluorescent solutions have enabled us to bring within the domain of optics many wave-lengths that were previously invisible. Stokes's explanation of this, as a degradation of energy quite analogous to the radiation of heat from a surface on which sunlight is shining, has been generally accepted. But whether the phenomena of fluorescence and phosphorescence are in general physical or chemical, has for the most part remained unknown or at least very uncertain. E. Wiedemann, who suggested the term luminescence to include all such phenomena, published in 1895 (*Annalen der Physik und Chemie*, p. 604, April 1895), in conjunction with Schmidt, a part of the outcome of an extended investigation undertaken with a view to clearing up these uncertainties. He has shown that it is often possible to distinguish between cases in which the emission of light springs from physical processes and those in which it is due to chemical action, or at least invariably accompanied by this. We have here, as in photography, a transformation of radiant into chemical energy, to which is superadded the retransformation of chemical into radiant energy of longer period, and this either at the same time or long after the action of the exciting rays. Indeed, between this process and that of photography in colours, the analogy is quite striking. What has generally been called phosphorescence is well known to be the effect of oxidation in the case of phosphorus itself and in that of decaying wood or other organic matter, which under certain conditions shines in the dark.

Wiedemann has shown that the shining of Balmain's luminous paint, and generally of the sulphides of the alkaline earths, is accompanied with chemical action. A long period of luminosity after the removal of the source renders highly probable the existence of what he now calls chemi-luminescence. A large number of substances, both inorganic and organic, have been examined both by direct action of light and by the action of kathode rays in a controllable vacuum tube through which sparks from a powerful electric influence machine were passed. Careful examination with appropriate reagents before and after exposure was sufficient to determine whether any chemical change had been produced. Thus the neutral chlorides of sodium and potassium, after being rendered luminous by action of kathode rays, are thereby reduced to the condition of subchloride, so as to give a distinctly alkaline reaction.

Many substances, moreover, which manifest no luminescence at ordinary temperatures after exposure, or which do so for only a short time, become distinctly luminescent when warmed. This striking phenomenon is sufficient to warrant the use of a special name, thermo-luminescence. Among such substances may be named the well-known sulphides of the alkaline earths, the haloid salts of the alkali metals, a series of salts of the zinc and alkaline earth groups, various compounds with aluminium, and various kinds of glass. Some of these after exposure give intense colours when heated, even after the lapse of days or weeks. That the vibratory motion corresponding to the absorption of luminous energy should maintain itself for so long a time as a mere physical process is highly improbable if not unparalleled. That it should become locked in, to be subsequently evoked by warming, certainly indicates the storing of chemical energy, just as the storage battery constitutes a chemical accumulator of electrical energy. Other indications that luminescence is as much a chemical as a physical phenomenon are found in the fact that the sudden solution of certain substances is accompanied by the manifestation of light, if they have been previously subjected to luminous radiation, but not otherwise: that alteration of colour is brought about by such exposure; and that friction or crushing may cause momentary shining in such bodies as sugar. There is no conclusive direct evidence thus far that such luminescence as vanishes instantly upon the withdrawal of light is accompanied by chemical action. But Becquerel demonstrated long ago with his phosphoroscope that there is a measurable duration of luminous effect when to the unaided eye the disappearance seems instantaneous (Becquerel, *Comptes rendus* 96–121). Wiedemann now shows that when this duration is considerable there is generally chemical change. Since duration is only a relative term it seems highly probable that even cases of instantaneous luminescence, commonly called fluorescence, are accompanied with chemical action on a very minute scale, and that all luminescence is therefore jointly physical and chemical in character. We have thus colour evoked by the direct action of light, which disturbs the atomic equilibrium that existed before exposure, and the manifestation of such colour continues only until the cessation of the chemical action thus brought into play.

The influence of very low temperature upon luminescence and photographic action has been studied by Dewar (*Chemical News*, lxx. p. 252, 1894). The effect of light upon a photographic plate at the temperature of liquid air − 180° C. is reduced to only a fifth of what it is at ordinary temperature; and at − 200° the reduction is still greater, while all other kinds of chemical action cease. In like manner, at − 80° calcium sulphide ceases to be luminescent; but, if illuminated at this low temperature and then warmed, it gives out light. At the temperature of liquid air many substances manifest luminescence which ordinarily seem almost incapable of it; such are gelatine, ivory, and even pure water. A crystal of ammonium platinocyanide, on the other hand, when immersed in liquid air and illuminated by the electric light, shines faintly when this is withdrawn. If now the liquid air be poured off so that the crystal rises rapidly in temperature, it glows brightly.

LUMINESCENCE AND PHOTOGRAPHY.

Photography, like luminescence, is a manifestation of the transformation of energy, most frequently of initial short wave-length. The production of colour by photography is nothing new. It was noticed by Seebeck nearly a century ago that silver chloride becomes tinted by exposure to ordinary light, with accompanying chemical change; that if then subjected a long time to red light it assumes a dull red hue, or a dull

bluish hue if held in blue light. It is likewise possible by proper selection of luminescent salts to produce a selected series of tints during and after exposure to those rays which are most effective in photography. But such colours cannot be made fixed and permanent. The problem of securing on the photographic plate a faithful and lasting reproduction of the various tints of a spectrum thrown upon it has baffled most of those who grappled with this subject. That it has been fully and quite satisfactorily solved cannot yet be affirmed, but the last few years have brought a far nearer approach to success than an equal number of decades previously. Viewed from the scientific standpoint the goal has certainly been touched, even if commercial demands are still made in vain.

STATIONARY LIGHT WAVES.

Two quite different methods are to be considered in tracing the recent development of this interesting application of optical principles. The first is originally due to Becquerel (*Am. de Chimie et de Physique* (3), p. 451, 1848), but lately, in the hands of Lippmann, it has been improved and brought much nearer to success than by its originator. It depends upon the production of stationary waves of light. Every one is familiar with the formation of stationary waves upon an elastic stretched cord, and with the acoustic exhibition of stationary air waves in a closed tube by Kundt's method of light powders. That similar loops and nodes must be produced under proper conditions by interference of waves of light would appear obviously possible; and so long ago as 1868 Dr. Zenker "Lehrbuch der Photochromie," Berlin, 1868), of Berlin, explained the photographic reproduction of colour, so far as it had then been accomplished, by reference to stationary light waves. But no definite proof of their production had been brought forward. A few years ago Hertz demonstrated objectively the electromagnetic waves whose existence had been foretold by Maxwell's genius; and with suitable apparatus stationary electric waves are now almost as readily made evident as are those of sound. Hertz's brilliant success stimulated his fellow countryman, Otter Wiener, to undertake the apparently hopeless task of producing and studying stationary light waves. Wiener's admirable work (*Wiedemann's Annalen*, Band xl. 1890, p. 203) excited great interest on the continent of Europe, but it has been singularly neglected in England and America. It is worth much more than a passing notice.

Assume a plane silvered mirror upon which a bundle of rays of monochromatic light fall normally so as to be reflected back upon its own path. The superposition of reflected and direct waves causes a system of stationary waves, but under ordinary conditions these are wholly imperceptible. The nodes are formed upon a series of planes obviously parallel to the reflecting plane at successive distances of a half wave-length. If now we consider a plane oblique to the mirror, it will cut these successive nodal planes in parallel lines, whose distance apart will be greater in proportion as the oblique plane approaches parallelism to the mirror. Although a half wave-length of violet light is only $\frac{1}{5000}$ of a millimetre, it is easy to conceive of the cutting plane forming so small an angle with the mirror that the distance between the parallel nodal lines shall be a thousand times a half wave-length. Such would be the case if the inclination of the cutting plane is reduced to a little less than four minutes of arc. The nodal lines would be $\frac{1}{5}$ of a millimetre apart, and readily capable of resolution if their presence can be manifested at all. Imagine a very thin transparent photographic film to be stretched along the oblique cutting plane, and developed after exposure to violet light as nearly monochromatic as possible. Then the developed negative should present a succession of parallel clear and dark lines, corresponding to nodal and anti-nodal bands along the oblique plane, the photographic effect being annihilated along an optical nodal line.

The realisation of a photographic film thin enough for such an experiment is quite conceivable when we remember that under the hammer gold is beaten into leaves so delicate that 8000 of them would be required to make a pile one millimetre thick. By electrochemical deposit, Outerbridge (*Journal of the Franklin Institute*, vol. ciii. p. 284, 1877) has made films of gold whose thickness is only $\frac{1}{1000000}$ of a millimetre, or $\frac{1}{80}$ of a wave-length of sodium light. Wiener obtained a perfectly transparent silver chloride film of collodion, whose thickness was about $\frac{1}{30}$ of a wave-length of sodium light. This was formed on a plate of glass and inclined at a very small angle to a plane silvered mirror which served as reflector. From an electric arc lamp the light was sent through an appropriate slit and prism, so that a selected spectral band of violet fell normally on the prepared plate in the dark room. The developed negative presented the alternate bands, in perfectly regular order, more than a half millimetre apart. Various tests were applied to guard against error in interpretation, and the existence of such stationary waves was proved beyond all doubt.

These waves, moreover, when polarised light was employed, furnished the means of determining the direction of vibration with relation to the plane in which the light is most copiously reflected when incident at the polarising angle, and thus of subjecting to experiment the question as to whether the plane of vibration is coincident with this plane of polarisation or is perpendicular to it. The former of these views was held by Neumann and MacCullagh, the latter by Fresnel. Let a beam of polarised light fall upon the mirror at an angle of about 45°. If the vibrations in the incident beam are parallel to the mirror, and hence perpendicular to the plane of polarisation, those of the reflected and incident beams will be parallel to each other, and hence capable of interference. But if the vibrations of the incident beams are in a plane identical with that of incidence, and hence in the plane of polarisation, the vibrations of incident and reflected beams are in mutually perpendicular planes, and hence cannot interfere. Wiener obtained interference fringes when the light was polarised in the plane of incidence, while the polarised in the plane perpendicular to this gave no trace of interference. The theory of Fresnel was thus confirmed experimentally. Again, the familiar phenomenon of Newton's rings shows us that on changing media there is a change of phase of the incident light, else the central spot where the two surfaces come into optical contact would be white instead of black. But there has been difference of opinion as to whether this change of phase occurs at the upper surface of the air film, where the light passes from glass to less dense air, or at the lower surface where it passes from air to more dense glass. In the latter event, there should be a node at the reflecting surface. Replacing the silvered plane surface by a lens in contact with the photographic film, Wiener obtained circular fringes with no photographic action, at the centre, showing the nodal point to be at the point of contact, and thus again confirming the theory of Fresnel.

COLOUR PHOTOGRAPHY.

The conditions being now specified under which stationary light waves are produced, let us imagine common instead of monochromatic light to be transmitted normally through a transparent sensitive film. Then a variety of stationary interference planes are produced. This is the underlying principle of the process employed by Lippmann in Paris, who, in 1892 (*Comptes rendus*, t. cxiv. p. 961, and t. cxv. p. 575), succeeded in obtaining a photograph of the solar spectrum in natural colours. Upon a surface backed with a reflecting mirror of mercury is a silver bromide albumen film, which has been treated with one or more aniline dyes to render it equally sensitive to waves of long and short period. After exposure and development the natural colours are manifested with brilliancy. Apart from the fundamental principle already expressed, it can scarcely be said that the *rationale* of the process has yet been very fully and clearly explained. Lippmann recognises the stationary wave systems, with maxima and minima of brightness in the film and corresponding maxima and minima of silver deposit. If the incident light is homogeneous, a series of equidistant parallel planes of equal photographic efficiency are produced in the film. If the plate after development is illuminated with white light, then to every point within the film there comes from below a certain amount of reflected energy which is a continuous periodic function of the distance from the reflecting surface. The total reflected light of any colour becomes then represented by the integral of this periodic function for the entire thickness of the layer. The solution of this integral brings the result that the intensity of the reflected ight decreases with increasing thickness of the layer, approaching zero as a limit, so long as this light is of different wave length from the homogeneous light employed for illumination of the plate. Only light of the same wave-length, or of an entire multiple of this, maintains a finite value. A similar consideration applies to each of the hues composing white light. By such mathematical considerations Lippmann (*Journal de Physique*, p. 97, 1894) reaches the conclusion that the light reflected from the plate must have exactly the same relations of wave-length as that with which the plate was illuminated.

For the Lippmann photographs, which at first required a very

long exposure, and could even then be satisfactorily viewed at only a single definite angle, it is now claimed that an exposure of only a few seconds is needed, and that the colours are visible at all angles of incidence so long as the plate is moist (*Journal de Physique*, p. 84, 1894). But, like the daguerreotypes of fifty years ago, they are incapable of multiplication, and great as is the scientific interest connected with them, it seems scarcely probable that they can long continue to hold an important place practically. The problem of ascertaining definitely the cause of the return of a colour the same as that which falls upon a given surface may seem to be solved mathematically, but the mastery of the physical conditions required to produce a single coloured negative, from which may be had any desired number of positives with varied hues accurately reproduced, is still in the future. From the very nature of stationary light waves it does not appear probable that the Becquerel method as improved by Lippmann will give the means of multiplying copies of a single picture. Wiener has lately published an elaborate research upon this subject (O. Wiener, *Wiedemann's Annalen*, pp. 225-281, June 1895), in which he recognises the necessity for the employment not of interference colours but rather of what he calls body colours (Körperfarben) due to chemical modification of the reflecting surface. M. Carey Lea (*American Journal of Science*, p. 349, May 1887), in 1887 obtained a rose-coloured form of silver photochloride which "in the violet of the spectrum assumed a pure violet colour, in the blue it acquired a slate blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged." But in the absence of any means of fixing these colours, a promising prospect brings disappointment.

While it is abundantly possible that coloured illumination upon suitable colour-receptive materials can give rise to similar body colours, we are still far from having these materials under control. There seems at present to be greater promise in another and quite different application of optical principles. The suggestion appears to have been first named by Maxwell (Royal Institution Lecture, May 17, 1861) in 1861 that photography in colours would be possible if sensitising substances were discovered, each sensitive to only a single primary colour. Three negatives might be obtained, one in each colour; and three complementary positives from these, when superposed and carefully adjusted, would present a combination that includes all the colours of nature. In 1873 H. W. Vogel in Berlin discovered that silver bromide, by treatment with certain aniline dyes, notably eosine and cyanine blue, can be made sensitive to waves of much longer period than those hitherto effective in photography. In 1885 he proposed to sensitise plates for each of a number of successive regions in the spectrum, and to make as many complementary pigment prints as negatives, which should then be superimposed. This somewhat complicated plan proved difficult in practice. In 1888 F. E. Ives (*Journal* of the Franklin Institute, January 1889), of Philadelphia, adopting the more simple Helmholtz-Maxwell modification of Young's theory of colour, applied it to the preparation of suitable compound colour screens which were carefully adjusted to secure correspondence with Maxwell's intensity curves for the primary colours. The result was a good reproduction of the solar spectrum. But to reproduce the compound hues of nature it is necessary specially to recognise the fact that although the spectrum is made up of an infinite number of successive hues, the three colour sensations in the eye are most powerfully excited by combinations rather than by simple spectral hues. Thus according to Maxwell's curves, the sensation of red is excited more strongly by the orange rays than by the brightest red rays, but the green sensation is excited at the same time. This fact has to be applied in the preparation of the negatives, while images or prints from these must be made with colours that represent only the primary colour sensations. Properly selected colour screens must therefore be used for transmission of light to plates sensitised with suitable aniline dyes; and the adjustment of ratios with this end in view is not easy. But it has been successfully accomplished. From three negatives thus made, each in its proper tint, positives are secured; and these are projected, each through its appropriate colour screen, to the same area upon a white screen. The addition of lights thus sent from the triple lantern gives the original tints with great fidelity.

Mr. Ives has devised a special form of camera by which the three elementary negatives are taken simultaneously, and also an instrument, the photochromoscope, in which a system of mirrors and lenses brings to the eye a combination similar to that projected with the triple lantern. A double instrument of this kind forms the most perfect type of stereoscope, bringing out with great vividness from the prepared stereographs the combined effect of colour, form and binocular perspective. It is only within the past year that these improvements have been perfected. By further application of the same principles, Mr. Ives has produced permanent coloured prints on glass, which do not require to be examined by the aid of any instrument. Each of these negatives is made with a coloured screen which transmits tints complementary to those which it is desired to reproduce. The three gelatine films are soaked in aniline dyes of suitable tint, and superimposed between plates of glass. When viewed as a transparency such a print gives a faithful reproduction of the natural colours.

The problem of colour reproduction is thus solved, not indeed so simply, but more effectively, than by the method of interference of light, or by those body-colour methods that have thus far been applied. To the imaginative enthusiasts who are fond of repeating the once novel information that "electricity is still in its infancy," it may be a source of equal delight to believe that photography in colours, a yet more delicate infant, is soon to take the place of that photography in light and shade with which most of us have had to content ourselves thus far; but so long as an instrument is needed to help in viewing chromograms, the popular appreciation of these will be limited. We may take a lesson from the history of the stereoscope. Yet it is gratifying to recognise the great impetus that this beautiful art has received during the last few years. We may quite reasonably expect that the best is yet to come, and that it will have an important place among the future applications of optical science.

THE INFRA-RED SPECTRUM.

Among the splendid optical discoveries of this century, probably the most prominent are photography and spectrum analysis, each belonging jointly to optics and chemistry. Photography was at first supposed to be concerned only with the most refrangible rays of the spectrum, but Abney and Rowland have photographed considerably below the visible red. Beyond the range thus attained qualitative knowledge was secured by Herschel, Becquerel, Draper, Melloni, Müller, Tyndall, Lamansky and Mouton. But our quantitative knowledge of this region began with the invention and use of the bolometer by Langley ("Selective Absorption of Solar Energy," *Am. Journal of Science*, March 1883, p. 169), whose solar energy curve has been familiar to all physicists during the last dozen years. During this interval the bolometer has been used with signal success by Ångström, Rubens, Snow and Paschen, who have made improvements not only in the instrument itself but in the delicacy of its necessary accompaniment, the galvanometer. The work of Snow (*Physical Review*, vol i. pp. 28 and 95), particularly, on the infra-red spectra of the voltaic arc and of the alkalies, and that done by him in conjunction with Rubens (*Astronomy and Astrophysics*, March 1893, p. 231), on refraction through rock-salt, sylvite, and fluorite, exhibited the capacities of the bolometer even better perhaps than Langley's previous work on the sun. But more recently with the collaboration of several able assistants, and more particularly the great ingenuity and mechanical skill of Wadsworth, the sensitiveness of Langley's galvanometer has been so exalted, and the bolometer connected in such manner with photographic apparatus as to make it an automatically controlled system, by which an hour's work now brings results superior in both quantity and quality to what formerly required many weeks or even months (Langley, "On Recent Researches in the Infra-red Spectrum": Report of Oxford Meeting of British Association, 1894). Not only is an entire solar energy curve now easily obtained in a single day, but even a succession of them. It becomes thus possible by comparison to eliminate the effect of temporary disturbing conditions, and to combine results in such a way as to represent the infra-red cold bands almost as accurately as the absorption lines of the visible spectrum are indicated by use of the diffraction grating. It will undoubtedly become possible to determine in large measure to what extent these bands are due to atmospheric absorption, and which of them are produced by absorption outside of the earth's atmosphere.

With the diffraction grating, supplemented by the radiomicrometer, Percival Lewis (*Astrophysical Journal*, June 1895, p. 1, and August 1895, p. 106), has recently investigated the infra-red spectra of sodium, lithium, thallium, strontium,

calcium and silver, attaining results which accord well with the best previously attained by those who had employed the bolometer, and which demonstrate the exceeding delicacy of the radiomicrometer as an instrument of research.

The Visible Spectrum.

To follow out all the applications of the spectroscope that have resulted in recent additions to our knowledge would carry us far beyond the scope of a single paper. It is possible only to make brief mention of a few.

For a number of years Rowland (*ibid.*, January to August 1895) has been investigating the spectra of all the chemical elements, photographing them in connection with the normal solar spectrum, and reducing them to his table of standards, which is now accepted everywhere. The work is of such magnitude that years more must elapse before its completion. It now includes all wave lengths from 3722 to 7200, and of these the list already published extends as far as wave-length 5150, or from ultra-violet nearly to the middle of the green.

Through the spectroscope chiefly has been established during the present year the discovery of the new atmospheric element, argon, by Lord Rayleigh and Prof. Ramsay (*Proc. Royal Society*, January 31, 1895); its remarkable property of green fluorescence when the electric spark is passed through it in presence of benzene, by Berthelot and Deslandres (*Comptes rendus*, June 24, 1895); and its association in meteoric iron and various minerals with helium, now proved to be a terrestrial as well as solar element, by Ramsay (NATURE, April 4, May 16, July 4 and 25, 1895), Crookes, Lockyer, and others.

With the diffraction spectroscope Rydberg (*Wiedemann's Annalen*, 1893–94) and Kayser and Runge (*ibid.*, 1888–95) have discovered interesting relations among the spectral lines of a large number of terrestial elements, arranging them into series whose distribution manifests chemical relationship quite analogous to that indicated in Mendelejeff's periodic law.

By photographing the spectrum of Saturn's rings and noting the relative displacement of the different parts of a spectral line, Keeler (*Astrophysical Journal*, May 1895, p. 416) has obtained a beautiful direct proof of the meteoric constitution of these rings, a confirmation of the hypothesis put forth by Maxwell in 1859, that the outer portion of the rings must revolve more slowly than the inner portion, and yet not satisfy the conditions of fluidity. His work has been repeated and confirmed by Campbell (*ibid.*, August 1895, p. 127) at the Lick Observatory.

The spectroheliograph devised by Hale (*Astronomy and Astrophysics*, March, 1893, p. 256) has enabled him to photograph, on any bright day, not only the solar photosphere and spots, but also the chromosphere and protuberances. He has made some remarkable attempts with this instrument to photograph the corona without an eclipse, unsuccessfully thus far, but not without promise of future success.

Polarised Light.

In the domain of polarised light, there have been several noteworthy recent researches. Nichols and Snow (*Philosophical Magazine* (5), vol xxxiii. p. 379) have shown that calcite, though readily transparent for the brighter rays of the spectrum, rapidly diminishes in power of transmission for waves of short period, so that for the extreme violet this power is scarcely half so great as for the yellow. The transmissive power of this crystal for the infra-red rays, between the wave-length limits of 1 micron and 5·5 microns, has been investigated with the bolometer by Merritt (*Physical Review*, May–June 1895, p. 424) who reaches the interesting result that the transmission curve for the ordinary ray is wholly independent of that for the extraordinary, the absorption being in general much greater for the former. Several sharp absorption bands are found for each ray. For radiations whose wave-length exceeds 3·2 microns, the absorption of the ordinary ray is almost complete, so that calcite behaves for such radiation just as tourmaline does for the rays of the visible spectrum. The independence of the two transmission curves is found to exist also for quartz and tourmaline, these curves for the latter crossing each other twice in the infra-red region.

The application of polarised light to the investigation of internal stress in transparent media was made more than forty years ago by Wertheim (*Comptes rendus*, 32, p. 289, 1851), who demonstrated that the retardation of the rays is proportional to the load. An extended series of such experiments has been lately made in America by Marston (*Physical Review*, September, October, p. 127, 1893) who, besides confirming Wertheim's conclusion, shows that, "for small strains at least, the colours seen in a strained glass body, when polarised light is passed through it in a direction parallel to one of the axes of strain, are measured by the algebraic difference of the intensities of those two principal strains whose directions are perpendicular to the direction of the polarised light."

A new substance with double rotatory power, like quartz, has been discovered by Wyrouboff (*Journal de Physique* (3), 3, 452, 1894), the neutral anhydrous tartrate of rubidium, which is unique in one respect. The rotatory power of the substance in the crystalline state becomes reversed in solution. This wholly new phenomenon introduces some perplexity in connection with certain molecular theories that have been formulated to account for double rotatory power.

Crehore (*Transactions* of the American Institute of Electrical Engineers, October 1894, p. 91) has ingeniously applied Faraday's principle of electro-magnetic rotation of the plane of polarisation in carbon bisulphide to the photographing of alternate current curves. Every variation in the magnetic field causes variation in the amount of light transmitted through a pair of crossed Nicol prisms. The combination becomes a chronograph with an index as free from inertia as the beam reflected from a galvanometer mirror. The same instrument has been applied to measurement of the velocity of projectiles (*Journal of the United States Artillery*, p. 409, July 1895), with results of exceeding interest to the student of gunnery.

Physiological Optics.

The temptation to dilate upon recent progress in physiological optics has to be resisted. The revision of Helmholtz's great book on this subject was interrupted by the death of the distinguished author, but the last part is now approaching completion under the care of his pupil, Arthur König, who, in conjunction with Diederici, has done much important work in this domain. The selection of hues for the three primary colour sensations has been slightly modified. Young selected the two extremes of the spectrum, red and violet, together with green, which is about midway between them. The hues now accepted by Helmholtz and those who follow his lead, including the great majority of physicists, are a highly saturated carmine red, an equally saturated ultramarine blue, and a yellowish green, corresponding somewhat to that of vegetation. The red and blue agree with those previously determined by Hering, but the rivalry between the two schools on the subject of colour sensation continues, and perhaps will last through a period commensurate with the difficulty of devising crucial experiments.

Independent theories of colour sensation have been brought out by Mrs. Franklin (Christine Ladd Franklin, "Eine neue Theorie der Lichtempfundungen," *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, 1892) in America, and by Ebbinghaus ("Theorie des Farbensehens," *ibid.*, 1893) in Germany. The former particularly is worthy of much more extended notice than can here be given. It may perhaps be quite properly called a chemical theory of vision. Light is always bringing about chemical changes in external objects, and the eye is the one organ whose exercise requires the action of light, while such chemical action is implied in the performance of most of the bodily functions, such as the assimilation of food and the oxidation of the blood. The bleaching action of light upon the visual purple, which is continually formed on the retina, has been known ever since the discovery of this in 1877 by Kühne, who secured evanescent retinal photographs in the eyes of rabbits. Mrs. Franklin considers that light sensation is the outcome of photo-chemical dissociation of two kinds of retinal molecules that she denominates grey molecules and colour molecules, of which the latter arise from the grey molecules by differentiation in such a way that the atoms of the outer layer group themselves differently in three directions, and the corresponding action of light of proper wave-length gives rise to the three fundamental colour sensations. She develops the theory with much skill, applying it particularly to the phenomena of retinal fatigue and colour blindness. To the objection that there is no direct proof of the existence of the assumed grey and colour molecules, it may be answered that Helmholtz himself fully recognised the uncertainty of the assumption that three different sets of nerves respond to the three fundamental colour sensations, and he admitted that these may be only different activities in the same retinal cone. The supposition of three adjacent cones, responding respectively to

the three fundamental sensations, is made only for the sake of greater convenience in discussion.

Indeed there is still much for us to learn regarding the nature of colour sensation. Among the yet unexplained phenomena are those of simultaneous colour contrast. The fact that a small brightly-coloured area on a grey background appears surrounded by its complementary tint is familiar enough. For its explanation it has been common to assume that there is unconscious motion of the observer's eyes, incipient retinal fatigue, an error of judgment, or fluctuation of judgment. This has been tested by A. M. Mayer (*American Journal of Science*, July 1893), who ingeniously devised methods for showing these contrast phenomena on surfaces large enough to match the colours with those of rotating colour discs, and thus to arrive at quantitative statements of their hues. When viewed through a small opening in a revolving disc the subjective contrast colour was unmistakably perceptible when the duration of passage of the opening was less than $\frac{1}{1000}$ of a second. The same effect was obtained in a dark room with instantaneous illumination of the coloured surface by the strong spark of an electric influence machine. The duration of illumination is thus almost infinitestimal, certainly not more than $\frac{1}{1000000}$ of a second. The hypothesis of fluctuation of judgment is thus shown to be wholly untenable. I have performed most of these experiments, either with Prof. Mayer or separately, and my testimony can therefore be united with his. The case is quite analogous to that of the perception of binocular relief, which was once explained as the product of a judgment, but was found to be always possible with instantaneous illumination. Prof. Mayer has devised a disc photometer based on colour contrast, with which the error of a single reading was found much less than with the Bunsen photometer.

The rotating colour disc has been applied by O. N. Rood (*American Journal of Science*, September 1893) to the determination of luminosity independently of colour, by taking advantage of the flickering appearance on a rotating disc upon which two parts have different reflecting powers. An extreme case of this is that of a white sector upon a black disc. At a certain critical speed the retinal shock due to momentary impression by white light becomes analysed into the subjective impression of spectral colours, the duration of the retinal sensation varying with the wave-length of the incident light. The law of this variation has been studied by Plateau ("Dissertation sur quelques propriétés des impressions produits par la lumière sur l'organe de la vue," Liège, 1829), Nichols (*American Journal of Science*, October 1884), and more recently with much precision by Ferry (*ibid.*, September 1892), who showed that retinal persistence varies inversely as the logarithm of the luminosity. For a given source of light separated into its spectral components, the yellow is the brightest. For this hue accordingly the retinal impression is shortest, and for violet it is longest.

Under appropriate conditions the after-effect on the retina has a certain pulsatory character, as first noted by C. A. Young (*Philosophical Magazine*, vol. xliii. p. 343, 1872) in 1872, and carefully studied within the last few years by Charpentier ("Oscillations rétiniennes," *Comptes rendus*, vol. cxiii. p. 147, 1891) in France, and Shelford Bidwell ("On the Recurrent Images following Visual Impressions," *Proc. Royal Society*, March 27, 1894) in England. A disc with properly arranged black and white sectors, if brightly illuminated and looked at while revolving at a moderate rate, becomes apparently coloured, just as a momentary glance at the sun causes the perception of a succession of subjective spectral hues which may last a number of seconds. The phenomenon in relation to the disc was known as early as 1838 (Fechner, *Poggendorff's Annalen*, 1838), and explained by Rood (*American Journal of Science*, September 1860) in 1860. The re-discovery of what has been long forgotten arouses all the interest of novelty. The "artificial spectrum top," devised by Benham (NATURE, November 29, 1894, p. 113) last autumn, excited interest on two continents, and was promptly copy righted by a prominent firm of opticians (*ibid.*, March 14, 1895, p. 463) in England. It would perhaps be equally enterprising to copyright the solar spectrum.

The limits of a single address forbid my touching upon the large and practically important subject of colour blindness. Indeed, in both physical and physiological optics much has been omitted that is abundantly worthy of attention. In behalf of my hearers it may be wise to take heed, once more, of the fate of Tarpeia, who was overwhelmed with the abundance of her reward.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Technical Education Board of the London County Council has just awarded 278 minor scholarships, viz. 178 to boys and 100 to girls in Elementary Schools; 334 scholarships of the same class were awarded last spring, upon the results of examination, so that altogether the number awarded by the Board in 1895 was 612.

AT a meeting of the Fellows of the Royal College of Surgeons, held on Thursday last in the theatre of the college, a resolution was carried, "that, in the opinion of the Fellows of this college, women should be admitted to the diplomas of the college," forty-seven Fellows voting for the resolution and only ten against. The Fellows alone form the electorate who vote for election to the council, and the effect of this resolution will probably cause the council (who are understood not to be unwilling) to open the examinations to women candidates. At a mixed meeting of Fellows and members, called by the President last November to consider an application from the Dean of the London Medical School for Women for this privilege, Mr. Clement Lucas's proposal to the same effect was negatived by the narrow majority of ten in a house of over a hundred.

IN connection with the new Technical Institute recently opened at Wandsworth, the London *Technical Education Gazette* recalls the interesting fact that the first technical school in this country was opened in Wandsworth. The third annual report issued by the Science and Art Department, in 1856, gives an interesting account of this first technical school, which was called the Wandsworth Trade School. The curriculum included partly subjects of general instruction and partly courses of trade instruction classified under three heads, according as they had relation to (1) the building trades, (2) the mechanical and engineering trades, and (3) the chemical and manufacturing trades. The new Technical Institute will, it is hoped, revive the traditions established by the pioneer school of 1856. In addition to an equipment grant of £500, the Technical Education Board has agreed to contribute £1000 to the maintenance of the institute for the current year, apart from any grants which it may make for the maintenance of the technical day school.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. ii. No. 2, November 1895.—Concerning Jordan's linear groups, is a paper by Prof. E. H. Moore, which was read before the Society in August last. It is a continuation of a paper read in November 1894, entitled "The group of holoedric transformation into itself of a given group" and is an exhaustive one supplemented by numerous bibliographical details.—Prof. A. S. Hathaway presented, at the same meeting in August, an elementary proof of the quaternion associative principle. Hamilton in his "Elements" writes: "The *associative principle* of multiplication may also be proved without the distributive principle, by certain considerations of *rotations of a system*, on which we cannot enter here." This note states that it is easy to see that such a proof is possible; but the details of it could not have presented themselves to Hamilton in an elementary form, or he would have seen that it was just the demonstration for which he was looking, simple in character, and direct in its application. We are not sure that we have not seen a proof somewhat similar to the Professor's, but we cannot recall it to our recollection. The proof given is a simple one.—The next article is a paper read at the October meeting of the Society, entitled "Moral Values," by Mr. R. Henderson. The author reminds us that the question of moral values in connection with the theory of probability has given rise to great diversity of opinion among mathematicians, and that Bertrand, in his classical work, dismisses it with contempt. More than the usual space is devoted to the notes and new publications.

American Meteorological Journal, December 1895.—Psychrometer studies, by Dr. Nils Ekholm. This article chiefly refers to the peculiar action of the wet-bulb thermometer near the freezing point of water. The author's observations and other investigations show that in an air saturated with water-vapour, the ice-covered bulb reads higher than the water-covered one, which, under those conditions, reads exactly as the dry bulb. These results are explained by Prof. W. Ramsay's experiments, which prove that there is a difference in the tension of water-

vapour and ice-vapour at the same temperature.—Meteorology as a University course, by R. de C. Ward, Instructor in Meteorology in Harvard University. The author's aim is to show the need of more instruction in meteorology, and to emphasise the fact that instruction is needed in general, rather than in the higher mathematical and physical meteorology; while the investigation of problems in the latter branches should be undertaken by eminent physicists who are fitted to do work of such an advanced character. The author considers that, at the present time, Germany takes the lead in the teaching and in the research of meteorology.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1895.—"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part X. On the complete Skeleton of an Anomodont Reptile (*Aristodesmus Rütimeyeri*, Wiedersheim), from the Bunter Sandstone of Reihen, near Basel, giving new Evidence of the Relation of the Anomodontia to the Monotremata." By H. G. Seeley, F.R.S.

The author has examined the fossil described by Dr. Robert Wiedersheim in 1878 as *Labyrinthodon Rütimeyeri*. The bones are differently interpreted:—

The reputed humerus is the interclavicle.

The reputed right and left coracoids are the pre-coracoid and coracoid of the right side.

The author regards the Labyrinthodont osteology as demonstrating close relationship with Ichthyosauria and Anomodontia. The group forms a branchiate division of the reptilian class.

The fossil now named *Aristodesmus* is identified as an Anomodont reptile chiefly on the basis of resemblances to *Procolophon* and *Pareiasaurus*.

The teeth are in sockets placed obliquely. The proportions of the vertebral column are those of *Echidna*, though the transverse processes are longer. The ribs are those of a Monotreme. The shoulder girdle resembles *Procolophon*, and the humerus does not show the peculiar lateral curvature seen in Monotremes. The ulna gives no evidence of an olecranon process; the pelvic bones are without acetabular or obturator perforations, are not anchylosed together, and the ilium is not expanded transversely. The femur is more slender than in *Echidna*. The fibula is prolonged proximally beyond the stout tibia, round which it may rotate. The proximal row of the tarsus is one large bone, the blended astragalus and os calcis.

Monotreme mammals make a close approximation to this fossil and other Anomodontia. A group *Theropsida* may be made to include Monotremata and Anomodontia. *Ornithorhynchus* shows pre-frontal and post-frontal bones, and has the malar formed as in Anomodonts.

Aristodesmus is placed in the Procolophonia, which has two occipital condyles, with the occipital plate vertical, without lateral vacuities; and has the shoulder girdle distinct from Pareiasauria in the separate pre-coracoid extending in advance fo the scapula.

PARIS.

Academy of Sciences, December 30.—M. Marey in the chair.—Development of the lymphatic vessels, by M. L. Ranvier. The author has examined the development of the lymphatic vessels in the embryo of the pig. By examining the mesentery, hardened in osmic acid and stained with picro-carmine, no lymphatic vessels can be observed in embryos of less than 9 cm. in length, the first signs appearing in those of 10 cm. The conclusion is drawn that the lymphatic system may be considered as an immense vascular gland, having its embryological origin in the venous system, and throwing its secretory product, the lymph, into the veins.—On the second scientific expedition of the *Princesse Alice*, by Albert First, Prince of Monaco. (See pp. 223-225.)—Note on the history of seas, by M. Suess. From the results of geological explorations, by MM. Mojsisovics, Waagen, and Diener, undertaken with special reference to the Trias formation, the conclusion is drawn that at that period the Pacific Ocean possessed two great branches—one (the Arctic branch) stretching over Eastern Siberia as far as Spitzbergen, the other across Central Asia and the Alps up to the Western Mediterranean.—On the acoustic analysis of mixtures of two gases of different densities, by M. E. Hardy. The method was capable of detecting one volume of illuminating gas in 1000 volumes of air.—Observations, made at the observatory of Algiers, of Brooks' and Perrine's comets, by MM. Rambaud and Sy.—Observations of Faye's comet and a minor planet, made at the Toulouse Observatory, by M. F. Rossard.—Observations of the sun, made at the observatory of Lyons, by M. J. Guillaume.—On some problems in variations, by M. G. Kœnigs.—On the summation of divergent series, by M. E. Borel.—On a new transformation of Taylor's theorem, by M. N. U. Bougaief.—On the unicursal varieties of three dimensions, by M. Antonne.—New properties of the cathode rays, by M. Jean Perrin. According to the views of Goldstein, Hertz, and Lenard, the cathode rays are due, like light, to a vibration of the ether; whilst Crookes and J. J. Thomson prefer to attribute the phenomena to matter charged negatively travelling with a high velocity. All the results of the extremely ingenious experiments of M. Perrier tend to show that the latter view is the correct one.—Observations on the zodiacal light, made at the observatory of the Pic du Midi, by M. E. Marchand.—On the elliptic refraction of quartz, by M. G. Quesneville. It is shown by a recalculation of Jamin's experiments, that the formula used by Jamin, calculated from Airy's theory, gives quite erroneous results in the neighbourhood of the axis.—The position in the solar spectrum of the calorific maximum, by M. Aymonnet. A comparison of the results obtained by various workers in this subject, shows that the position of this maximum depends not only on the composition of the prism, but also on the other parts of the spectroscope which reflect or transmit the ray. The continual variation in the intensity of the solar radiation is also a source of grave error in these measurements.—On the mechanical production of extreme temperatures, by M. E. Solvay. Remarking on the liquefaction of air in quantity recently achieved by M. Linde, M. Solvay observes that he used the same principle, the successive expansions of the same quantity of gas, in 1886, but, having imposed on himself as practical conditions that the pressure must not exceed 5 atmospheres, and not take more than 15-horse power, the lowest temperature he actually reached in this way was $-95°$. It is further pointed out that inversely the same principle would serve to reach extremely high temperatures, were it not for the fact that these can be more easily attained by electrical means.—On the combustion of acetylene, by M. H. Le Chatelier. Mixtures of acetylene with air containing less than 7·7 per cent. of acetylene, burn completely to water and carbon dioxide, for proportions of acetylene between 7·7 per cent. and 17·4 per cent., the products consist of water, carbon monoxide and dioxide, water, and hydrogen, in mixtures containing more acetylene than this free carbon and unburnt acetylene are found. With oxygen, mixtures containing anything between 2·8 per cent. and 93 per cent. of acetylene will catch fire; with air the limits are 2·8 per cent. and 65 per cent. In tubes, these limits are narrowed down, until in tubes of 0·5 m.m. diameter or less it is impossible to propagate a flame.—On the fixation of nitrogen by the metals of the alkaline earths, by M. L. Maquenne. After referring to his earlier work on this subject, the author describes a simple lecture experiment illustrating the ease with which nitrogen is absorbed. A mixture of lime and magnesium powder heated in a hard glass tube over a Bunsen burner will, in five minutes, absorb 96 per cent. of a confined volume of air.—On crystallised titanium and the combinations of titanium and silicon, by M. L. Levy. A silicide of the composition Ti_2Si has been isolated.—On the rotatory power of rhamnose in a state of superfusion, by M. D. Gernez. The rotatory power of fused rhamnose diminishes regularly with rise of temperature; at 100° it is only 61 per cent. of its value at 0°, and is in all cases less than that deduced from the rotatory power of its solutions.—On some dithiazolic derivatives, by M. C. Lauth.—Syntheses of acid chlorides and amide hydrochlorides, by M. A. Colson. The following reaction is found to occur.

$$RCN + R^1.CO_2H + 2HCl = R.CO.WH_2.HCl + R^1COCl.$$

when R, R^1 may be methyl or ethyl. This reaction is suggested as a method for preparing acid chlorides without the use of the phosphorus chlorides. If the acid is replaced by its anhydride the yield is improved.—Action of the halogens upon formaldehyde, by M. A. Brochet. In the case of chlorine, the primary reaction is $CH_2O + Cl_2 = CO + 2HCl$. The $COCl_2$, previously observed, is a secondary product.—On essence of lemon, by

MM. P. Barbier and L. Bouveault.—Study in germination, by M. J. de Rey-Pailhade.—On the simultaneous determination of the mineral and organic acidity in the juice of the beetroot, by M. D. Sidersky. Advantage may be taken of the indifference of Congo-red paper to the organic acids, but a simpler method is to use a colouring matter present in the juice itself.—The origin of the three-colour theory of the optic nerve, by M. J. P. Durand. A recognition of the work of Thomas Young.—On the influence of lecithin on the growth and multiplication of organisms, by M. B. Danilewsky.—Comparative study of the buccal mass of gasteropods, by M. A. Amaudrut.—Cephalopods from the stomach of a cachalot, caught at the Azores, by M. L. Joubin.—Some effects of the synodic revolution of the moon on the distribution of atmospheric pressures in the autumn season, by M. A. Poincaré.—On a meteor observed in Algeria, December 14, 1895, 10h. 15m. p.m., by M. J. Triboulet.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 9.

SOCIETY OF ANTIQUARIES, at 8.30.
MATHEMATICAL SOCIETY, at 8.—On a certain Ternary Cubic: Prof. Lloyd Tanner.—Further Communication on Boltzmann's Minimum Function: S. H. Burbury, F.R.S.—Examples illustrating Lord Rayleigh's Theory of the Stability or Instability of certain Fluid Motions: A. E. H. Love, F.R.S.
ROYAL INSTITUTION, at 3.—Sound, Hearing, and Speech: Prof. McKendrick, F.R.S.

FRIDAY, JANUARY 10.

MALACOLOGICAL SOCIETY, at 8.—List of South Australian Pleurotomidæ with Descriptions of New Species: G. B. Sowerby.—Descriptions of New Land Mollusca from New Zealand and Macquarie Island: Henry Suter.—The Genus Hyalimax, or a near Ally (Neohyalimax), in Brazil: Dr. H. Simroth.—On a Collection of Slugs from the Sandwich Islands: Walter E. Collinge.
ROYAL ASTRONOMICAL SOCIETY, at 8.
CLINICAL SOCIETY, at 8.30.

SATURDAY, JANUARY 11.

ASSOCIATION FOR THE IMPROVEMENT OF GEOMETRICAL TEACHING (University College), at 11.—At 2.—Business Meeting.—Geometrical Methods: Dr. Larmor.
ROYAL BOTANIC SOCIETY, at 3.45.

SUNDAY, JANUARY 12.

SUNDAY LECTURE SOCIETY, at 4.—Pasteur and his Work: Prof. Percy Frankland, F.R.S.

MONDAY, JANUARY 13.

MEDICAL SOCIETY, at 8.30.

TUESDAY, JANUARY 14.

ROYAL INSTITUTION, at 3.—The External Covering of Plants and Animals: its Structure and Functions: Prof. C. Stewart.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water-Supply: Hon. R. C. Parsons.
ZOOLOGICAL SOCIETY, at 8.30.—A Preliminary Revision and Synonymic Catalogue of the Hesperiidæ of Africa and the adjacent Islands, with Descriptions of some apparently New Species: Rev. W. J. Holland.—On a Collection of Butterflies obtained by Mr. R. Crawshay in Nyasaland between the Months of January and April, 1805: Dr. Arthur G. Butler.—On a Newly-discovered Modification of the Iris in the Eyes of certain of the Ungulata adapted for assisting Vision: Dr. G. Lindsay Johnson.
ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Astigmatism and a New Stigmatic Portrait Lens: H. L. Aldis.
ROYAL ASIATIC SOCIETY, at 3.
ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.

WEDNESDAY, JANUARY 15.

SOCIETY OF ARTS, at 8.—The Making of a Great University for London: Prof. Silvanus P. Thompson, F.R.S.
ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—Election of Council and Officers.—The Speculative Method in Entomology: Prof. Meldola, F.R.S., President.
ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Meeting.—Election of Council.—Address by the President, A. D. Michael.
ROYAL METEOROLOGICAL SOCIETY, at 8.—Annual General Meeting.
BRITISH ARCHÆOLOGICAL ASSOCIATION, at 8.

THURSDAY, JANUARY 16.

ROYAL SOCIETY, at 4.30.
LONDON INSTITUTION, at 6.—Experiments with Incandescent Lamps: Prof. Fleming, F.R.S.
LINNEAN SOCIETY, at 8.—On the Fistulose Polymorphinæ and the Ramulinæ: Prof. T. Rupert Jones, F.R.S., and F. Chapman.
SOCIETY OF ARTS, at 4.30.—The Shan Hills: their Peoples and Products: Colonel R. G. Woodthorpe, C.B., R.E.
SOCIETY OF ANTIQUARIES, at 8.30.
CHEMICAL SOCIETY, at 8.—The Acetylene Theory of the Luminosity of Hydrocarbon Flames: Prof. Vivian B. Lewes.—And other Papers.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums.—Inaugural Address of the President, Dr. John Hopkinson, F.R.S.
NUMISMATIC SOCIETY, at 7.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—More about Argon: Lord Rayleigh.
QUEKETT MICROSCOPICAL CLUB, at 8.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Iron Tunnels: W. O. Leitch.
EPIDEMIOLOGICAL SOCIETY, at 8.—Experiences in Relation to Cholera in India from 1842-79: Surgeon-General C. A. Gordon, C.B.

SATURDAY, JANUARY 18.

ROYAL INSTITUTION, at 3.—To the North of Lake Rudolf and among the Gallas: Dr. A. Donaldson Smith.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Annuaire pour l'an 1896, publié par Le Bureau des Longitudes (Paris, Gauthier-Villars).—Le Mouvement: E. J. Marey (Paris, Masson).—Principii della Teoria Matematica del Movimento dei Corpi: Prof. G. A. Maggi (Milano, Hoepli).—Elementary Treatise on Electricity and Magnetism: Profs. Foster and Atkinson (Longmans).—History of the Cholera Controversy: Sir G. Johnson (Churchill).—Quain's Elements of Anatomy, 10th edition, Vol. 3, Part 4, Splanchnology: Profs. Schäfer and Symington (Longmans).—Comité International des Poids et Mesures. Procès-Verbaux des Séances de 1894 (Paris. Gauthier-Villars).—Travaux et Mémoires de Bureau International des Poids et Mesures, tome xi. (Paris, Gauthier-Villars).—Transactions of the Royal Society of Victoria. Vol. iv. A Monograph of the Tertiary Polyzoa of Victoria: Dr. P. H. MacGillivray (Melbourne).

PAMPHLETS.—Special Map of British Guiana (Philip): Frederic Kitton (Redway).—Guide to the British Mycetozoa exhibited in the Department of Botany, British Museum (Natural History) (London).—Ninth Annual Report of the Liverpool Marine Biology Committee and their Biological Station at Port Erin: Prof. W. A. Herdman (Liverpool).

SERIALS.—National Review, January (Arnold).—Norges Geologiske Undersögelse, Nos. 10 to 17 (Kristiania).—Bulletin of the American Mathematical Society, December (New York).—Geographical Journal, January (Stanford).—Science Progress, January (Scientific Press)—Mind, January (Williams).—Zeitschrift für Wissenschafte Zoologie, Sechzigster Band, Drittes Heft (Williams).—Annals of Scottish Natural History, January (Edinburgh, Douglas).—Proceedings of the Aristotelian Society, Vol. 3, No. 1 (Williams).—Brain, Part 72 (Macmillan).—Journal of the Royal Agricultural Society of England, Vol. 6, Part 4 (Murray).—Minnesota Botanical Studies, Bulletin No. 9 (Minneapolis).—Scribner's Magazine, January (S. Low).—Académie des Sciences de l'Empereur François Joseph I. Bulletin International Classe des Sciences Mathématiques et Naturelles, II.—Journal of the Royal Statistical Society, December, Stanford).—Geological Magazine, January (Dulau).

CONTENTS.

THURSDAY, JANUARY 16, 1896.

EUCLID AND HIS EDITORS.

Euclid's Elements of Geometry. Edited for the Syndics of the Press by H. M. Taylor, M.A. Books I.–VI., XI., XII. Pp. xxii + 658. (Cambridge: at the University Press, 1895.)

THE appearance of a school edition of "Euclid's Elements," published under the auspices of the Cambridge University Press, provokes reflections upon the strange position so long maintained in this country by Robert Simson's authorised version (so to speak) of the work of the Alexandrian geometer. For more than a hundred years the Simsonian text enjoyed an unchallenged supremacy; and not so very long ago any proposal to amend it, or to teach elementary geometry by means of some other book, was regarded as something very like profanity.

It is only in accordance with the nature of things that this professed veneration for Euclid should coexist with a profound ignorance of the real *Elements*, and of the other extant works of their author. To this day the reputation of Euclid is not unlike that of the wizard Virgil in the Middle Ages. Most educated Englishmen are quite unaware of the existence of those books of the Elements which are not read in schools; there is even a legend current in some quarters that they were destroyed in MS. by Euclid's wife! For the only good critical edition of Euclid's works (Heiberg's, in the Teubner Series) we must go to Germany; and it would be interesting to know how many English mathematicians are acquainted with the original text, and how many English scholars have had the curiosity to find out whether "parallel*o*piped" (rhyming with "biped," by the way) is vouched for by the Greek. To crown the absurdity, it is just that book of the Elements which is of greatest permanent value that, by common consent, is never read.

After all, the study of the real Euclid may very fitly remain the privilege of the minority; the really urgent need is that geometry should be taught rationally and effectively in our schools. Happily, we have outlived the glacial period which still prevailed in the early part of this century; and all good authorities are practically agreed upon the main lines of reform. The weight of opinion among experienced teachers seems still to be in favour of retaining at least the framework of the Elements, and of following, generally, Euclid's sequence of propositions. In favour of this course there is something to be said, independently of the base consideration of examination requirements. That there is a certain advantage in a recognised order of propositions will probably be admitted by most of those who have wandered in the chaos of geometrical conics; and with regard to Euclid's methods of proof, it is doubtful whether the various alternatives which have been suggested are really easier for a schoolboy to learn and understand. A beginner is very apt to appeal to his powers of intuition in a quite illegitimate way; and in trying to reproduce a proof which depends upon superposition or symmetry he often loses himself in a haze of words, and fails to give a sound demonstration. Proofs of this kind may very well be included, of course; but should not, we think, take the place of the more formal ones in the text.

Mr. Taylor's book is one of several which, while harmlessly masquerading as "editions" of Euclid, are really excellent treatises on elementary geometry, based upon the lines which Euclid has laid down. Signs of the wholesome reform that has taken place, meet the eye on every page. The antiquated terms, the clumsy repetitions, the tiresome rigmaroles of Simson's text are done away with; notes and explanations are given where necessary; additional propositions are introduced; and there is an abundance of exercises, carefully graduated, and properly distributed throughout the book, instead of being hidden away at the end of it. One of the extraordinary superstitions of former days was that nobody could do a geometrical deduction unless he had previously learnt three books of Euclid by heart; it is to be hoped that this ridiculous theory is at length abandoned. Some boys, of course, can never do a "rider," even the easiest; but those who have any capacity can be started successfully after learning the first five propositions, or even before.

School Euclids may be roughly divided into two classes, according as symbols of abbreviation are used or avoided. While such a notation as AB^2 for "the square on AB" is decidedly objectionable, the use of symbols of *mere* abbreviation is a matter of taste. Personally we detest them, and rejoice that they do not appear in Mr. Taylor's treatise. Brevity has been secured in the proper way, by a careful choice of words, and not by a host of contractions and ugly symbols for "circle," "parallelogram," and so on.

There are several attractive features in Mr. Taylor's book to which attention may be drawn. The selection of additional propositions is very good, and it is needless to say that the proofs given are very elegant. There is a most interesting collection of proofs of Pythagoras's theorem (i. 47); Ptolemy's theorem is proved by means of Book iii.; and Gergonne's construction for the circles touching three given circles, is to be found on p. 458. There are also sections dealing with poles and polars, coaxal circles, projective rows and pencils, Pascal's and Brianchon's theorems for the circle, centres of similitude, and inversion (including an account of Peaucellier's cell); besides this, there is a long supplement to Book xi., which discusses, *inter alia*, properties of tetrahedra and parallelepipeds, spherical geometry, the regular solids, and the elements of perspective. In conclusion, we have the determination of the surface and volume of a sphere. It will be seen from this mere list how liberally Mr. Taylor has interpreted his editorial function, and how many important theories he has contrived to touch upon; at the same time, the book is anything but "stodgy," and cannot fail to interest and stimulate an intelligent reader. There is a good index, and here and there brief historical notes are given.

It is instructive to observe how Mr. Taylor has dealt with Euclid's text. He explains in the preface that he began by translating the first book; he ended by "giving up all idea of simple translation, and retaining merely the substance of the work, following closely Euclid's sequence of propositions in Books i. and ii., at all events." To see what this means, let us take propositions 1–26

in the first book. Besides alterations of minor importance, proofs other than Euclid's are given for propositions 5, 6, 14, 24, and the first part of 26; and two additional propositions (10 A, 10 B) are introduced for the purpose of proving that all right angles are equal. It may be thought by some critics that it is injudicious to have discarded altogether so many of Euclid's demonstrations; but, in any case, additional evidence is given of the impossibility of returning to the text of the Elements pure and simple. That the idea of doing so should have, apparently, presented itself to the mind of an accomplished geometer like Mr. Taylor, is very remarkable.

The great merits of Mr. Taylor's work are sure to meet with general appreciation. Experience alone can show whether it approaches more nearly than any of its numerous predecessors the ideal of a school text-book. The reasons why one book turns out to be a good one for teaching purposes, and another not, are often difficult to discover; but we should expect the present volume to undergo the ordeal successfully.

So far as we have been able to test it, the book appears to be very accurately printed; some of the figures are not so exactly drawn as they might be, and the lines (except in Book xi.) strike us as being too thin. The occasional use of small letters instead of capitals, to denote points, is also, we think, undesirable. It is so important to preserve young eyes from unnecessary strain, that even minute details of this kind deserve attention. There is, alas! only too much reason to be assured of the editor's sympathy with the spirit of this remark; for, as we learn from an affecting passage in the preface, Mr. Taylor lost his sight while his book was going through the press. To the mathematician, as to his twin-brother, the poet, sight is perhaps the most precious of nature's gifts of sense. Happily in each case the imaginative faculty, which feels the loss of vision so keenly, not seldom supplies its best alleviation; and we sincerely trust that Mr. Taylor is still able to find solace in the pursuit of his favourite science.

In conclusion, we cannot refrain from quoting the extraordinary regulation for the Cambridge Local Examinations, as printed on the fly-leaf of Mr. Taylor's book:—

"Proofs other than Euclid's will be admitted, but Euclid's axioms will be required, and *no proof of any proposition will be accepted which assumes anything not proved in preceding propositions in Euclid.*"

The clause which we have ventured to italicise makes proofs other than Euclid's not only admissible, but necessary; while the retention of the axioms becomes superfluous, except perhaps for sentimental reasons. How the regulation can be complied with is not very clear to the ordinary mind; perhaps a recent "demonstration" of Euclid's fifth postulate (Simson's eleventh axiom) may be the first instalment of a new geometry without assumptions. Or, possibly, the regulation may be intended as an object-lesson, to illustrate the truth of the assertion that Cambridge graduates cannot write plain English, and thus to support the present agitation for imposing some test of composition in the Little-Go?

G. B. M.

RECENT HISTORY OF THE CARBOHYDRATES.

Kurzes Handbuch der Kohlenhydrate. By B. Tollens. Band ii. Pp. xvi + 407. (Breslau: E. Trewendt, 1895.)

THERE is not much apparent analogy between the province of the carbohydrates and the African continent; but viewed as arenas of research, discovery, and appropriation, they present very similar histories. The author of the work before us has accepted the mission of record-keeper in the march of annexation in the first-named and more abstract region, and he must have found his office during the last ten years quite as engrossing as those who provide us with maps of the once dark continent.

The volume is supplementary to that which appeared in 1888 under the same title (Band i.), and deals with events in this extremely interesting field of enterprise, up to last year (May 1895). If it were not for the self-evident fitness of the number 7, we might have pronounced the selection of time for antiquating the earlier volume as somewhat hasteful; but that would have been before acquainting ourselves with the contents of the present vol. ii. Afterwards, we have merely to record our conviction that seven years has become "quite a" period in "chemical time." Of course, this effectual antiquating of vol. i. in no sense lessens its historical value, and it will continue to occupy a not "too top-shelf" in our library of working manuals.

Like its predecessor, the book is substantially a reprint of an article or monograph written for the "Handwörterbuch der Chemie" (Ladenburg). It is necessarily therefore cyclopædic in style, and restricted in its treatment of the subject to the experimental results of investigations, and their immediate bearings upon current developments of chemical theory pure and simple. Seeing that in the compass of 370 pages the author deals with the substance of 1200 original papers, it will be gathered that he has not indulged in much speculative discussion of the problems peculiar to this borderland between chemistry and physiology. He has produced rather a rigid *précis* of positive results, and, backed by his well-deserved reputation for thoroughness and critical exactitude, the book needs no further recommendation to chemical specialists. But the subject appeals to a wider circle of readers, and it may not be out of place to examine the author's work from a somewhat broader point of view.

The lines of classification adopted are, of course, those laid down and developed by Émil Fischer, and expounded by himself in his two monumental dissertations, "Synthesen in der Zuckergruppe" (*Deut. Chem. Ges. Ber.*, 1890, 2114; 1894, 3189). These are dealt with in the earlier sections. The basis of the isomeric relationships of the glucoses and their immediate derivatives is briefly set forth. In respect of constitution, the discussion as between an aldehyde or ethylene oxide formula for the typical glucose is impartially summed up. We may remark on this important point, that there is no suggestion of the probable influence of aqueous solution. The very recent researches of Lobry de Bruyn (*Rec. Trav. Chim.*, 1895, 14, p. 203), showing that mannose, dextrose, and fructose are reciprocally transformed, each into the two

others by the action of sodium hydrate in aqueous solution, are a striking illustration of the mobile equilibrium of the typical CO group, and of the ease with which its migration is determined. That changes of structure take place in aqueous solution is evidenced by the phenomena of rotation, and the influence of hydrolytic agents points to a very direct connection with changes of "ionic" equilibrium. A grouping of these relationships, with a not too positive conclusion as to their significance, would have added a suggestive section.

From constitution the author proceeds to configuration, the section consisting in the main of Fischer's well-known tables. In the next edition these may be accompanied with advantage by the mnemonic symbols recently proposed by Lobry de Bruyn (*Chem. Zeitung*, 1895, No. 75), or by some similar pictorial concession to the limitations of the average memory. In the nomenclature of the group, there is the usual struggle between systematic and trivial terms. There is some ambiguity created in the numerical basis of the terminology, as between the number of C atoms in the molecule of a simple carbohydrate, and the number of such simple units in the condensed molecule of a "polysaccharide." Thus the term "triose" designates a glycerose of the dimensions C_3, and the sugars of dimensions $3C_6$. The author evidently avoids innovations in this direction, and it is not for us to step in where the leaders fear to tread. In the following sections, dealing with the experimental methods of general significance, whereby the relationships of constitution and configuration have been elucidated, the treatment of the subject is of the briefest. The sections which suffer most under the severe discipline of brevity are those devoted to "the formation of the carbohydrates in nature," and to "fermentation." The former is chiefly devoted to the recent work of Brown and Morris, and the latter to Fischer's observations on the relationship of fermentation to configuration. It is evident that much matter of the greatest interest to physiologists is left unnoticed. We can only regard the omission as expressing the author's judgment that this province still refuses to yield to the positive methods of a systematic handbook. From this condensed review of the generalities of the subject, we are taken at once to the description of the individual compounds in systematic order: glucoses, saccharoses, and polysaccharides. It would be gratuitous to say anything in commendation of these sections. They constitute a condensed reproduction in strictly systematic order of the very prolific researches of the last few years, and the labour which they represent on the part of the author will be fully appreciated by specialists. Anything which might be said in depreciation of these sections could only be translated into the common-place that no one can be a general specialist; and in the chemistry of the carbohydrates the specialising process has passed into the second degree, as witness the literature of the sugars, of starch, of cellulose. The consequent difficulty of subordinating the parts of so wide a subject to the main plan has been effectually overcome in the work before us. The remainder of the work is devoted in order to the alcohols, to derivatives of the cyclic hexamethylene, and lastly to the complex groups of acids which stand in relationships of the first or more remote degrees to the carbohydrates.

The work, therefore, satisfactorily exhausts the recent history of the subject in its systematic relations; on the other hand, to those who have the fear that the objectives of the science in this fertile field of research are being rapidly exhausted, we may speak a word of comfort in the reflection *l'appétit croît en mangeant*. It is evident that, although the writer limited himself to the plan of a somewhat "high and dry" dictionary article, and in enlarging his text to confer upon the article the standing of an independent monograph, keeps well within the limits of history, the subject-matter is continually breaking bounds and revealing by implication the remarkable further developments which it promises on every hand. The natural history of the carbon compounds remains to be written. There is abundant evidence in the recent history of the chemistry of the carbohydrates that this new objective of the science is taking positive shape. These compounds constituting in a prominent degree the arena for the primary processes of natural organic synthesis, it is in the order of things that the fundamental relationships of these compounds should be first elucidated as the necessary basis of plant physiology. It would take us much beyond the obvious limits of the matter in hand to attempt a discussion of the many broad physiological issues directly raised by the results of the last seven years' investigations. We would suggest that the author's next volume should treat this side of the subject specially and adequately. We should also suggest an historical preamble and a brief survey of the chief developments marking the period. With these slight qualifications, we heartily commend the book to all students of natural science.

OUR BOOK SHELF.

Practical Inorganic Chemistry. By Dr. G. S. Turpin, M.A. Pp. 158. (London: Macmillan and Co., 1895.)

IT is gratifying to all who are interested in scientific education to know that instruction in elementary science in this country is steadily improving, both in methods of teaching and in the subjects taught. In the spring of this year, a new scheme of work for organised science schools was issued by the Department of Science and Art. These schools include all the best carried on in connection with the Department, and for some time a definite scheme of study, extending over three years, has been followed in them. What the Department did recently was to issue a remodelled scheme for such schools, embodying several commendable features. Elementary practical physics was introduced as an obligatory subject, and a course of real chemistry was substituted for the drill of test-tubing, which had gone under the name of practical chemistry for so long. Dr. Turpin's book has been designed to meet the improved requirements; and, as it has had a reasonable basis for its construction, it possesses many good qualities. The course of work described begins with weighing, measuring, the determination of relative density, and other elementary physical principles; then follows a chapter on mixtures and compounds, and another on the setting-up of apparatus. After this fundamental knowledge has been experimentally studied, the constitution of the air is investigated, and then the most important gases, and common chemical compounds, form the subjects of the student's work for the remainder of the course. We cannot speak too highly

of the introduction of such a course of work as is herein described. It encourages thought, creates interest in chemistry, and furnishes the kind of knowledge most likely to prove of advantage in after years. Not only in organised science schools, but in every school where chemistry is taught, the course described in this book could be profitably introduced.

Observaciones de precision con el Sextante. Por el Conde de Cañete del Pinar, Cápitan de Fragata Retirado. Pp. 180. (Madrid: Ricardo Álvarez, 1895.)

A DESCRIPTION of the sextant and the uses to which it can be applied is here given in seven chapters, of which the first describes the instrument, and shows how it may be corrected. Following, we have four chapters on different means of the determination of latitude by means of stars, showing the methods trigonometrically, and also giving examples. The accuracy of observations taken by the sextant is graphically shown by two tables, giving the latitude obtained on several successive days. Lastly, we have a description of the means by which time is determined, and also how the longitude is obtained by means of the moon and stars. Throughout the book there are numerous examples, and no pains have been spared to make it useful.

First Stage Mechanics. By F. Rosenberg, M.A. Pp. 296. (London: W. B. Clive, 1895.)

THIS book has been made to fit the requirements of the elementary stage of theoretical mechanics of solids, as laid down in the syllabus of the Department of Science and Art. It is the first volume of a new series of Departmental text-books, and it possesses all the characteristics of the literature of the University Correspondence College Press; by which remark we mean that the text is concise, the examples numerous, and the comparative importance of the sections is indicated by the thickness of the type in which they are printed. What more does a student require, who is learning theoretical mechanics for examinational purposes?

The Story of the Solar System. By George F. Chambers, F.R.A.S. Pp. 202. (London: George Newnes, Limited, 1895.)

WE are glad to be able to state that the twenty-eight illustrations in this book are better than those in the companion volume on the "Stars," by the same author. Mr. Chambers has contrived to compress an immense amount of information within a small compass, and his descriptions possess the double quality of simplicity and attractiveness. We do not know of a book in which so much is told about the solar system within such narrow limits.

British Guiana and its Resources. By the author of "Sardinia and its Resources." Pp. 104. (London: George Philip and Son, 1895.)

THE question of frontier between British Guiana and Venezuela is now so much to the front, that a large public will be interested in this description of the history, features, and resources of the region in which the debatable land lies. The book will be found valuable not only on this account, but because it is full of information useful to visitors to British Guiana. Travellers of all tastes and inclinations will find that the country offers many attractions, and is as wide a field for observation and collection as could be desired.

Mammals of Land and Sea. By Mrs. Arthur Bell (N. D'Anvers). Pp. xii + 191. (London: George Philip and Son, 1896.)

ALTHOUGH this volume will assist its readers to know the general characteristics of members of the mammalian family, it possesses no novel features, and the illustrations belong to a past age. Some readers may find the book interesting, but few will pronounce it attractive.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A New Method of Measuring Temperature.

THE recent publication of papers dealing principally with thermometry, by Mr. Griffiths, and by the Kew Standardising Bureau, has suggested to me that the publication of a new thermometric method which I have used for some years may be of use.

Briefly, in this method two thermo-junctions are used; one is placed, protected or not, as circumstances dictate, in the substance of which the temperature is to be measured, the other in the bulb of an air or nitrogen thermometer. This junction is blackened, and may or may not be protected, but should be in the same state as the other. The bulb of the air thermometer may or may not be silvered or platinised. Within the bulb of the air thermometer is placed a coil of platinum wire, in series with this being a carbon resistance and a storage battery. The bulb of the thermometer is protected by a layer of slag-wool, or, if this cannot be obtained, of asbestos; or a sheath of polished metal may be used. In the thermo-electric circuit a low resistance galvanometer is placed. I prefer to use a d'Arsonval.

The *modus operandi* is as follows. The free thermo-junction is placed in the substance whose temperature is to be measured. The galvanometer is immediately deflected. The circuit of the platinum heating coil is then closed, and the carbon resistance screwed down till the galvanometer needle comes back to zero, or until making and breaking the thermo-electric circuit produced no movement of the needle. When this is the case the temperature of the air or nitrogen in the bulb will evidently be the same as that of the substance to be measured, and can be directly read off in any of the usual ways on the thermometer. I prefer myself to use the constant volume method.

It is necessary, of course, that the thermo-junctions be both in the same physical state. This is generally secured with sufficient accuracy by cutting the wire from the middle of a much larger piece which has been well annealed. In connection with other work I have found that two samples of metal, chemically identical but having different rigidities and thermo-electric powers, may always be brought to identical states by heating for a time at white heat in vacuo, first introducing, if necessary, oxygen or hydrogen to decompose any hydride or oxide combined with the metal. I have never found it necessary to do this in making thermo-junctions, but its use is recommended to experimenters who are studying the physical properties of metals.

The advantages of this method are as follows:

(1) No assumption is made in regard to any law of variation of thermo-electric effect with temperature.

(2) No assumption is made with respect to variation of voltage of standard cell in relation to temperature. The error due to the fact that the saturation of the sulphate solution of the standard cell always lags behind the temperature, and that due to the fact that the temperature is never known exactly, are thus done away with.

(3) No assumption in regard to temperature or temperature coefficient of wires is made.

(4) Both junctions being maintained at the same temperature for approximately the same length of time, and under the same conditions, the likelihood of changes in physical state, produced by one wire being annealed more than the other, is reduced to a minimum.

(5) The temperature is read directly by a nitrogen thermometer, and no intermediate standards need be used.

(6) No complicated apparatus is needed, the only instrument used being the galvanometer, and that only as an indicator. The only standard used is the kathetometer for measuring the height of the mercury column.

The only assumption made is that the air in the bulb is at a uniform temperature throughout. This assumption is justified, however, by experiment. In 1890 Mr. A. E. Kennlly and the writer made a number of experiments to determine the temperature coefficient of the electrical resistance of copper wire. In these experiments the wire was wound in two coaxial coils in the bulb of an air thermometer, the idea being that there would

probably be a difference of temperature between the coils, and the mean would be taken. On testing the matter, however, no such difference was found, even up to the highest temperature used, 250° C. If any difference existed it was less than one-tenth of 1° C., as that amount could have been measured. This being the case in a narrow tube where the air circulation was hindered by a number of mica discs (see *Physical Review*, February 1893, for description of apparatus), it is improbable that there is any appreciable difference when there is no hindrance to the air currents except the heating coil of platinum.

I have never used the apparatus for very high temperatures, but see no reason why it should not be so used; and it would apparently present a number of advantages for such work, chief among which is the fact that the temperature would be obtained by direct comparison with an air or nitrogen thermometer, and no assumptions made as to the law of variation of thermo-electric force with temperature.

It can, of course, be made self-recording by placing a recording pressure gauge in place of the mercury column, the observer simply keeping the galvanometer at zero by manipulation of the carbon resistance.

It is obvious that platinum resistance coils can be used instead of the thermo-junctions, the platinum resistance coils forming two arms of a Wheatstone bridge, and the galvanometer placed across them.

A method of measuring the heat conductivity and temperature coefficient of metals devised by me, and at present being used by one of my students, may be of interest. A metal bar, well annealed, polished, and with special precautions taken to preserve homogeneity of physical state, has its ends placed in two mercury baths, A and B. The bar is protected from radiation by concentric polished metal tubes. A is heated electrically, and B cooled by a water tube. In the regular laboratory exercise, I have been in the habit of letting the students use thermometers. But in this case, where accurate results are required, capillary tubes are led off from A and B, filled with mercury, thus forming a thermo-junction. Another thermo-circuit has its junctions placed at the entrance and exit of the cooling water. It would, of course, be possible to measure the thermo-voltage directly by standard cell; but instead of this, in the present method, the two thermo-circuits are balanced against one another, the elements which are immersed in the water being chosen so as to have a much higher thermo-voltage than the copper-mercury couple. It is seen, without much difficulty, that by this means the conductivity of the copper may be measured without knowing more than one temperature, and that only approximately, to a considerable degree of accuracy. As the experiments are not concluded, I am unable to state definitely what the value of the method is, but the indications are that it will prove successful. REGINALD A. FESSENDEN.

Western University of Pennsylvania.

On Crookes' Spectrum of Helium.

IN his investigation on the spectrum of helium,[1] Crookes has examined the spectrum of five different samples of gas, two being developed from cleveite (No. 1 and No. 5), another from uraninite (No. 2), and two from bröggerite (No. 3 and No. 4). Sample No. 5 has been prepared with special care, and is designated "helium purissimum." The five spectra are by no means identical, and it has been concluded that besides helium there are other gases present. E. A. Hill[2] has even gone so far as to infer the existence of at least fifteen new elements from the comparison of these five spectra. Thirty of the seventy-nine wave-lengths measured by Crookes coincide (within the limits of error) with wave-lengths that we have measured in the spectrum of cleveite gas.[3] But the remaining forty-nine lines, many of which are strong, do not coincide with any of ours. As far as we know, it has not been noticed that thirty-three of these forty-nine lines almost certainly belong to argon, among them nearly all the stronger lines. Six more may also be argon lines, but the identification is rather doubtful. Two lines in all probability are mercury lines, which naturally are likely to appear in a vacuum-tube made by means of a mercury pump. One line may be due to carbon. The table on p. 246 contains a list of the forty-nine wave-lengths that do not coincide with wave-lengths that we ascribe to helium, and gives their probable origin. The wave-lengths of argon lines are taken from Kayser (*Chemical News*, August 30, 1895), Eder and Valenta (*Ber. der Wiener Akad.*, October 24, 1895), and from Crookes' own measurements.

3890·5 and 3885·9 are strong lines that have been seen in the spectra of all five samples. Crookes considers them as satellites or components of the strong line between them, the wave-length of which is 3888·785 according to our measurements. But as our photographs show that this line is single, or if not single has a weak component 0·05 lower, which can only be observed with much greater dispersion than Crookes has used, we are inclined to believe that 3890·5 and 3885·9 are spurious lines due to some error of apparatus having made their appearance on account of the enormous energy of 3888·8.

Of the five remaining lines, three are only of intensity 2. The two stronger ones have only appeared in the gas from uraninite, and may possibly belong to a substance hitherto unknown. But it is far from being established.

C. RUNGE AND F. PASCHEN.

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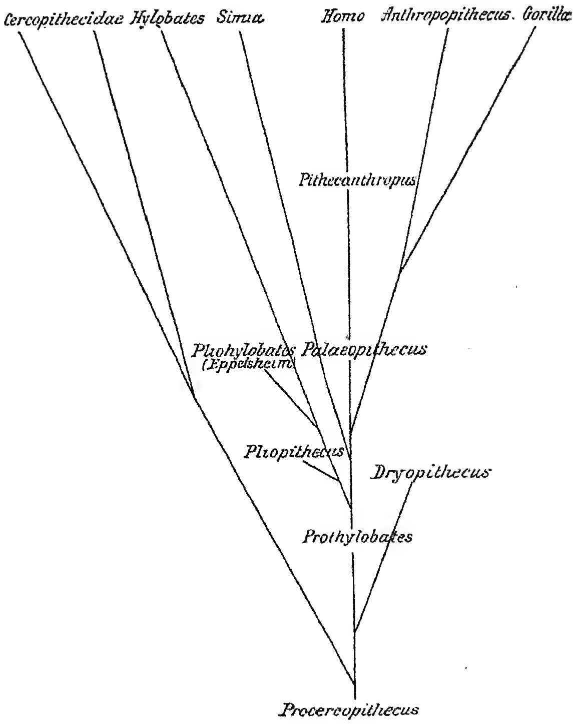
[1] *Chemical News*, August 23, 1895. reprinted in NATURE, August 29, 1895.
[2] *American Journal of Science*, November 1895.
[3] *Berichte der Berl. Akad.*, July 1895. See also NATURE, September 26, 1895.

The Place of "Pithecanthropus" in the Genealogical Tree.

IN the report on the scientific meeting of the Royal Dublin Society on November 20, in NATURE of December 5, 1895, it is stated that I placed Pithecanthropus in the genealogical tree, drawn by Prof. Cunningham, below the point of divarication of the Anthropoid apes from the human line. This indeed I did. But this statement could be misleading as to my real views on the genealogy of Pithecanthropus, such as I stated them already on p. 38 of my original memoir ("*Pithecanthropus erectus*, Eine menschenähnliche Uebergangsform aus Java," Batavia, 1894), and more fully at the last meeting of the Anthropological Institute of Great Britain and Ireland, on November 25.



It may not be superfluous to explain my views here by means of the accompanying diagram, representing the evolution of the Old World apes from a hypothetical common ancestor, whom I call Procercopithecus.

In Prof. Cunningham's tree, figured in NATURE of December 5, p. 116, he regards the left branch as all human, the right one as entirely simian, and he placed Pithecanthropus midway between recent Man and the point of divarication.

	Intensity. Sample No. 1	2	3	4	5	Sample not specified.	Argon. Red. Crookes.	Int.	Eder and Valenta.	Int.	Argon. Blue. Crookes.	Int.	Kayser.	Int.
5062·15						3					65·	10	·258	2
4931·9 *a*						3								
4870·6 *b*		7												
4847·3		7							·95	3			·965	3
4805·6		9							6·10	5			6·185	6
4764·4 *c*						2			4·99	4			5·030	3
4735·1		10							6·03	6			6·069	5
4658·5		8							8·01	4			·070	4
4579·1		3							·49	3			·531	5
4559·4						2								
4544·1						5			5·28	4			5·231	5
4520·9		3							2·45	8				
4511·4		5					09·5	9	10·83	10	09·5	8		
4497·8						2			8·62	1			8·874	1
4437·1						1							9·541	1
4428·1		10							30·35	4	26·5	10	30·365	6
4424·0		10							6·15	6	22·5	10	6·170	9
4399·0 *d*		10							{ 01·17 { 00·20	5 3	99·5	10	{ 01·165 { 00·269	5 3
4378·8		8							9·79	4	76·5	9	9·832	6
4371·0		8							{ 1·46 { 0·89	3 2	69·0	9	{ 1·504 { 0·921	4 4
4348·4		10							·11	8	48·5	10	·231	10
4333·9		10					33·5	9	·64	10	33·5	9	·701	2
4298·7		5					00·5	9	00·18	10	99·0	9		
4281·3		5											3·084	3
4271·0		5					72·0	8	2·27	10				
4258·8	7	7	7	7	7		59·5	9	9·42	10	59·5	8		
4227·1		5							8·30	4			{ 8·301 { 7·142	5 2
4198·6	Very faint	9		Very faint			98·0	9	{ 00·76 { 98·42	10 10	98·0	9		
4189·9	Very faint	9		Very faint			91·5	9	{ 91·15 { 90·76	6 6	91·5	9		
4181·5	Very faint	9		Very faint			83·0	8	2·07	9	83·0	8		
4178·1						1							{ 9·478 { 8·477	1 1
4157·8		8	Veryfaint	Very faint			59·5	10	8·63	10	59·5	10		
4044·3	Present	Present	Absent	Absent	Absent	9	44·0	9	4·56	8	44·0	8		
4012·9	7	7	7	7	7				3·97	4	13·0	8	3·997	6
3962·3 *e*	4	4	4	4	4								0·620	2
3948·2	Very faint	10					48·5	10	{ 9·13 { 7·70	10 5	48·5	9		
3917·0 *f*					2									
3913·2 *g*	Absent	Present	Absent	Absent	Present	4							4·918	3
3890·5	9	9	9	9	9									
3885·9	9	9	9	9	9									
3874·6		6											5·413	3
3800·6 *h*					4								{ 3·383 { 0·429	2 1
3642·0		8									3·27	3		
3627·8		5												
3247·5 *i*					2									
2536·5 *j*					8									
2479·1 *k*					4									
2446·4 *l*					2									
2419·8					2									

The only lines that certainly remain not accounted for, leaving aside those where the coincidence is not very satisfactory, are:

	1	2	3	4	5	Sample not specified.	Crookes.	Int.	Eder and Valenta.	Int.	Crookes.	Int.	Kayser.	Int.
4870·6		7												
4559·4						2								
3917·0					2									
3890·5	9	9	9	9	9									
3885·9	9	9	9	9	9									
3627·8		5												
2419·8					2									

a There is an argon line at 4933·4 stronger in the blue spectrum seen on our own plates, but not mentioned by Kayser nor by Crookes. Crookes gives 4938 int. 10 as a line of the blue spectrum of argon. But as there is no strong line at 4938, we are inclined to think that it is meant to be 4933. *b* The deviation is too great to suggest the argon line 4879 (Crookes), though its intensity is about the same as that of 4848, and would therefore suit very well. *c* Schuster has also measured these lines, and gives them, together with 4879 and 4726, as characteristic argon lines of the spectrum at atmospheric pressure. *d* H. F. Newall, experimenting with one of our vacuum tubes filled with cleveite gas, found that these five lines appeared in the periphery when it was put into a coil through which the discharge of a Leyden jar passed. We could not detect the lines on photographs taken with an induction current passing through the tube in the ordinary way. *e* Coincidence very uncertain. *f* H. F. Newall gives a line 3918·8 int. 5,* but at this place there is no argon line on our photographs. *g* Coincidence doubtful. *h* Coincidence doubtful. *i* We see a line in the blue spectrum of argon at 3248·4 on our plates. *j* 2536·65 strong mercury line. *k* 2478·66 strong carbon line. *l* 2446·96 mercury line, intensity 6.

* *Astrophysical Journal*, May 1895.

Now I could find no place for the fossil Javanese form, which I consider as intermediate between Man and Anthropoid apes, in any of the branches of *that* tree, only in the third chief line, the main stem, very near to the point of divarication.

Owing to the same circumstances, which indirectly prevented me from explaining my own views on the matter at Dublin, I did not then reply to two remarks of Prof. Cunningham, which omission I now wish to repair by the following declaration.

(1) I did not exaggerate the relative height and quality of the cranial arch, which Prof. Cunningham had in view (the arch of the glabella-inion part of the calvaria) in Hylobates. The profile outline of the skull of *Hylobates agilis* figured, directly from the bisected skull, on p. 8 of my memoir, is even somewhat higher than that of Pithecanthropus, of which I have an accurate bisected cast before me. In the latter the height of the said cranial arch is exactly equal to the one-third part of the glabella-inion line, and in the skull of a *Hylobates agilis* it is about 2 mm. higher than the third part of the corresponding line. If in the mentioned diagram in my memoir that line in the gibbon skull were drawn equal in length to that of the fossil calvaria, instead of the natural size, this would be more apparent there than it is even now. The said cranial arch of a *Hylobates syndactylus* in the same diagram is much lower than that of the other gibbon species, and the same arch in the chimpanzee would even be lower than in *Hylobates syndactylus*. It is easy to find skulls of Semnopithecus with a higher "cranial arch" than the chimpanzee has. Further, between different individuals of the same ape species and of man, we find great differences in the height of that arch.

All these facts tend to show that there is no reason for regarding the height *of the suprainial part* of the calvaria as of real importance in our judgment on the place which any human-like being should occupy in the genealogical tree.

(2) In my original memoir (p. 7), I have already pointed out that the occiput of the fossil skull is very ape-like, especially gibbon-like. But, nevertheless, the inclination of the planum nuchale on the glabella-inion line is very different from that of all the Old World apes. These accord very nearly with one another in the degree of this inclination, whilst the angle in Pithecanthropus approaches closely human conditions. I not only compared photographs of the median line of the skulls, but also the bisected skulls with the bisected exact cast of the fossil calvaria. The means which I have taken to determine the degree of this declination are therefore, I believe, entirely calculated to yield trustworthy results.

EUG. DUBOIS.

An Anagram.

Is it too frivolous to suggest the accompanying anagram?

Pithecanthropus erectus.
Pursue the person, catch it!

Kew, December 10, 1895. E. H.

The Barisal Guns and Similar Sounds.

WITH reference to the letters that have appeared in NATURE on the above subject, I have read with interest that by Mr. G. B. Scott, of the Indian Survey, in your last issue. The question, I think, arises, Are we not dealing, in India at least, with two very different phenomena? Are these sounds like that of heavy ordnance, which are heard occasionally at the base of the Eastern Himalayas and the Garo and Khasi Hill Range,[1] the same as those longer known and more familiar as the "Barisal Guns"? Mr. Scott's description of the sounds he heard when on board the steamer moored in the narrow channels near the sea, are remarkably like wave action. He says: "Sometimes a single report, at others two, three or more in succession, never near, always distant, but not equally distant. Sometimes the reports would resemble cannon from two rather widely separated opposing forces, at others from different directions but apparently always from the southward, that is, seaward." This is precisely what one would hear on a still night, when an ocean swell was coming up the Bay of Bengal and breaking all along a low shore with an undulating outline stretching many miles east and west.[2] I have been twice round by Barisal in a river steamer, and once by native boat, which took many days; but I was not fortunate enough to hear the sounds.

[1] *Vide P. A. S.* Bengal. Mr. La Touche, of the Geological Survey, p. 201, in "Report on Barisal Guns."
[2] *Vide* same Report. Letter by Mr. A. Manson, p. 208.

Regarding the distant booming reports, that are heard further inland, I was, I think, one of the first to notice and put them on record. In the *Proceedings* of the Asiatic Society of Bengal, March 1869, *vide* "Notes from Asaloo, North Cachar, on the Great Earthquake of January 10, 1869," after giving some details of the daily shocks that were recorded up to the 17th of that month, I find the following on p. 98. "Very noteworthy is the distant report of a heavy gun on January 19, heard towards the west at 1h. 49m. 19s. p.m. (I was sitting at work at a table outside the office tent); the time I took immediately by chronometer, as I fully expected a shock to follow. Another very loud explosion was heard from Mahadeo Peak at midnight of the 29th, and again from the same peak at 7 a.m. the next morning, the 30th; but no shock came after, on either occasion.

"I may here mention that last cold weather, on several occasions when I was in the North Cachar Hills, I heard, at various times, the like distant reports, resembling exactly the firing of big guns at a great distance. In one or two places the country people had noticed it, and they even used the expression that it proceeded from the earth (*the earth speaks*).

"These subterranean explosions must be heard over large areas, and it would be interesting if they could be noticed, or rather if those hearing them would make the matter public; I have no doubt there are many individuals who will remember having heard such sounds." The reports like big guns, "top chalta," as the natives expressed the sound, heard at Asaloo in January, during a period of great seismic activity, were, I consider, intimately connected with it; and that the similar reports, solitary instances not continuous, heard in the previous year at different places in the same range, were also of a subterranean nature. Seismic sounds are not always accompanied by a disturbance of the earth conveyed to the senses. I find in my journal the following.

"*Nongtung, in Jaintia Hills, December* 21, 1887."

"While seated at dinner, a curious rumbling sound was heard in the west. Mr. Ogle immediately said, 'that is the rumble of an earthquake,' and we waited with intense expectation for several seconds for the shock, I with my watch out ready to take its duration; but it never came. We then thought it might have been a herd of elephants coming up the ridge, and, disturbed by our camp fires, had rushed off through the jungle; but on going into Jawai on Christmas Day, we learnt that a shock had been felt there on the same date and time, and that it apparently came from the west."

The best-defined unaccountable sound occurred when I was surveying the Bhutan Dooars in the spring of 1865. I have some remembrance of putting it on record at the time, perhaps in my annual report. I was standing at the plane-table in the forest twelve miles south-west of Buxa, when the report of a heavy gun was heard in the direction of the mountains, clear and distinct, yet a long way off, followed closely and at irregular intervals by two other discharges. The natives with me immediately said "the Bhutias have attacked Buxa," which was not unexpected, for they had only lately retaken Dewan Giri. A short time after, on reaching the main path from Buxa to Balla, an irregular cavalryman of the Jat Horse came by, carrying despatches for Buxa Fort. I wrote a hasty note to an officer there to ask what was going on, and I received in due course a reply saying not a shot had been fired there or anywhere else. These reports were louder and more distinctly like artillery fire than any I afterwards heard in the hills further to the east. These last had the nature of a very, very distant boom, coming from no well-defined direction. Particularly do I recall one occasion when we were going down a narrow spur on the southern face of the Jaintia Hills, on a glorious fine day, the view over the basal slopes all clothed in forest, and the plains and low hills of Sylhet beyond fading into the high horizon of the delta of the Brahmaputra. The sound seemed to come from out of the distance along the foot of the mountains—west and south.

As a primary cause, every possible kind of force has been suggested—fireworks, *i.e.* bombs, cannon, bursting bamboos in jungle-fires, thunder-claps, landslips, and the falling of river-banks. I am familiar with the sounds produced by all these causes, and the last-named was particularly brought under my notice when proceeding by boat on the Megua and Brahmaputra, and from Gowhatty on a raft made of two dug-out canoes to Doobri, 125 miles. I have often seen and heard the report which

a large long mass of sand, suddenly giving way and falling forward from the vertical face of a sand-bank or river-bank on to the water, will produce, and the very long distance it will be heard up and down the river.

In the vicinity of such great rivers, at such a spot as Chilmari Ghât, which I know well, we must be rather sceptical with regard to sounds being any other than of this nature. The reports are very likely to be repeated, for the wave produced on the water will set another mass falling some way off, and even the wave of air may do the same to a mass just tottering, and bring it all down together (see also Report in *Proceedings* of Asiatic Society, Bengal, p. 207, regarding the echo from one side of the river to the other, so well described by Mr. Manson).

Mr. W. T. Blanford has suggested to me landslips for the reports heard near Buxa; but this is a sound I have heard on the bursting of a landslip dam in the Himalayas: the sound was of the nature of a rumble, not a report. A fall of rocks into a valley from any height would produce, I think, a still more prolonged rumbling sound—more like that of the avalanche.

Shalford Park, January 7. H. H. GODWIN-AUSTEN.

ALLOW me to mention, for the information of those of your readers who take an interest in this subject—a considerable number, to judge from the correspondence that has lately appeared in these columns—that a very complete account of the phenomenon is now being published in *Ciel et Terre*, a review devoted to astronomy, meteorology, and terrestrial physics, published twice monthly at Brussels, from the pen of M. Ernest Van den Broeck, curator of the Royal Museum of Natural History of Belgium, who has devoted much time and labour to a study of the subject. The first article, containing a complete historical review of the subject, appeared on December 1; the second, on the 16th, dealt with the accounts of the phenomenon received by M. Van den Broeck from various observers in Belgium; and future articles will be devoted to a study of the facts as reported from Bengal, to the causes of the phenomenon, and to the methods employed in determining its origin.

I may mention that the true rendering of the word *mist-poeffers*, the name given to the sounds by the fishermen, is not *fog-dissipators*, but, as appears from a note on the etymology of the word by one of M. Van den Broeck's correspondents, it should more correctly be translated *fog-belchings* or *fog-hiccups*, the French rendering of the word *poeff* being *renvoi* or *hoquet*. The point is of some importance, since the sounds do not appear to have any effect, as one might imagine from the signification of the name, as it first appeared in NATURE, in the dispersal of fogs. T. D. LA TOUCHE.

Boring a Coral Reef.

WILL you be good enough to allow me to correct a somewhat important oversight in the note in last week's NATURE, on the work of the Coral Reef Committee of the Royal Society. You mention that the Royal Society has granted the sum of £800, and the Government a gunboat, for the expedition. Even with this help, however, it would have been impossible to undertake the work unless the Department of Mines of the New South Wales Government, largely through the good offices of Prof. Anderson Stuart, had granted to the Committee the use of a complete set of boring tools and appliances, with an engine and boiler. Further, the Department has relaxed the somewhat stringent restrictions usually placed on the use of the tools, owing to the difficulties which will be experienced in a waterless and sparsely inhabited island. For such generous assistance, and to Prof. Stuart, who has helped in many different ways, the Committee cannot be too grateful. W. W. WATTS,

(Joint-Secretary of the Royal Society's Coral Committee).

Sutton, Surrey, January 11.

Variability of Red Stars.

ACCORDING to a notice, which I found in NATURE'S "Astronomical Column" of November 14, 1895, my theory of the variability of red stars should demand, that the bright lines of hydrogen should be produced there at a low temperature and in a condition never tested by experiments.

I will try to show that this objection is not valid.

The bright lines in red stars are considered by me as caused by the recently much studied phenomenon of luminescence, *i.e.* by a production of light not due to elevation of temperature, and thence not subjected to Kirchhoff's law of absorption.

In the cooled atmospheres of the red stars two causes of luminescence can be expected—two causes, which according to the relatively low temperature of the combinable elements and condensable vapours, with which these atmospheres are filled up, must act there much more energetically than in other stars. These two well-studied causes of luminescence are chemical action and electricity.

If we first consider chemical action, it may be stated, by the way, that the supposed chemical combination in a cooling star does not necessarily require a very low temperature. Acetylene, for instance, can be generated in the electric arc. Now we know that acetylene is a compound actually present in the atmospheres of some of the most cooled stars. It is abundantly absorbing in the stars III *b* and, according to Prof. Lockyer, not unlikely radiating in the stars of his Group II. (Vogel's Class III *a*).

If therefore we assume that it is principally acetylene, which is generated in the cooling atmospheres of the red stars, bright lines of hydrogen may be expected there. These lines are then precisely caused as those of sodium, potassium, lithium and thallium in the experiments of Pringsheim, being absent as long as the sodium vapour is only strongly heated, but appearing immediately as soon as in this heated vapour some chemical change occurs.

It must be conceded, however, that in the case of hydrogen this chemical luminescence has not yet been actually observed in our laboratories. But in the case of hydrogen we have another luminescence, which is daily experienced. It is the glow in Geissler tubes, where (whatever may be the heat of the individual shining molecules) the average temperature of the glowing gas does not necessarily exceed the common temperature of our atmosphere, and cannot therefore be considered as the cause of the glowing of the gas.

As this luminescence is caused by electric discharges, and as such discharges (according to what we know about the electrical phenomena connected with the formation of clouds and hail in our own atmosphere) are likely to be expected in atmospheres, which are filled up with vapourous matter ready to condense in clouds, the hypothesis of an electrical luminescence of the hydrogen in the atmospheres of red stars seems very plausible. That hypothesis demands that the bright lines should be especially conspicuous in stellar atmospheres, where the alternation of vapourisation and recondensation is also very conspicuous, *i.e.* (according to my theory explained in the November and December numbers of *Knowledge*) in the atmospheres of red variables and Novæ, where that intermitting condensation and vapourisation of dark obscuring cloudy matter is the very cause of the variability. Now we know that this demand is fully verified. Prof E. C. Pickering has stated as a rule that, with perhaps a single exception, every red star with bright hydrogen lines is *eo ipso* variable. And this rule has proved to be so sure, that Mrs. Fleming could discover numerous new variables from the bright lines of their spectra (*Astrophys. Journal*, I. p. 27, 411; II. p. 198).

Eventual bright lines in the stars of Vogel's Class I. and II. may be explained perhaps (as Prof. Scheiner has recently shown in his "Untersuchungen über Spectra der Helleren Sterne," p. 223) by the hypothetical presence of a gigantic incandescent atmosphere, whose radiation around the bundle of rays coming to us from the star's much smaller photosphere is greater than the absorption it causes in that bundle; but in the more cooled atmospheres of red stars the chemical compounds there present, attest a temperature relatively so low that we cannot conceive that atmospheres to be filled up to such a gigantic height with hydrogen so enormously heated as to become (if that still doubtful phenomenon is possible) bright shining by incandescence.

Such enormously heated hydrogen and chemical compounds cannot permanently coexist in a stellar atmosphere. The coexistence of chemical compounds and bright shining hydrogen is only possible if the brightness of the latter is due to luminescence.

The ideas here suggested may be considered as an instance of a likely fruitful application of the study of luminescence to stellar spectroscopy. If they are right, they give, I think, a plausible explanation (1) of the connection between the variability of a star and the frequent brightness of its spectral lines, and (2) of the very remarkable fact that both variability and bright lines are so often observed precisely in those stars, whose

atmospheres, according to the chemical compounds or their spectra, are coolest. A. BRESTER.

Delft (Holland), November 30, 1895.

THE above amplification of Dr. Brester's views, as to the cause of variability in red stars, calls for a few remarks. Although opinions may differ as to the constitution of stars of Group II., it is generally agreed that those of Group VI. are in an advanced state of condensation, with cool, absorbing atmospheres, and it is in the latter group of stars that we find the full development of the fluted absorption spectrum which Dr. Brester ascribes to acetylene. Experimental evidence does not certainly indicate that this gas is responsible for the dark flutings observed, for other compounds of carbon give a similar spectrum; but, to whatever the flutings may owe their origin, they are a result of Kirchhoff's law. Notwithstanding that it is in these stars of Group VI. we should most expect the bright lines on Dr. Brester's theory, no bright lines have been recorded in variable stars belonging to the group; that is, there is no visible chemical luminescence.

It is in the variables of Group II. that the bright line phenomena occur, but the associated dark flutings of metals, or their compounds, do not lead us to suppose that the temperature is lower than in the other group of stars with fluted spectra. Hence, luminescence does not seem to be more probable in Group II. than in Group VI., unless we accept the view put forward by Mr. Lockyer, that the physical constitutions of the two groups of stars are essentially different. If the stars of Group II. consist of uncondensed swarms of meteorites, it is certainly conceivable that the luminosity of the hydrogen in the interspaces may be partly due to electrical excitation; this view involves the supposition that these stars are becoming hotter.

It may be further remarked that there is abundant experimental evidence to show that the line spectrum of hydrogen can coexist with a fluted spectrum. Acetylene, for instance, exhibits such a mixture, and hence luminescence is not more necessary to explain the luminous phenomena in the case of hydrogen than in the case of the absorbing vapours which give the flutings associated with them in stars.

THE WRITER OF THE NOTE.

Mount Wosho.

As my name has been mentioned in NATURE for December 5, 1895 (p. 107), in connection with recent explorations in Africa, allow me to say that snow clothing on Mount Wosho must have been added by an outsider, for in page 110 of my work on Ethiopian geography, published five years ago, I have expressly said that snow does not exist in that country. In page 387 of the same volume, I have given up all Mount Wosho's claims to an immense height; but I still think it exists as a mountain, and that it ought not therefore to be wiped off the map.

Your criticism induces me to explain how I tried to sketch one in Upper Ethopia. I first employed the common method by recording hours of travel and bearings by compass; but I was then forced to suppose the variation of the needle. Disturbing attractions could not be eliminated, and it was seldom possible to check my road by observed latitudes. However, as a warning to my successors, I published this tedious work in my "Géodésie d'Ethiopie" (Paris, 1873), a volume of 502 quarto pages.

This first attempt to map the country being fruitless, I turned all my attention to using a theodolite, and collected in 318 stations more than 4000 bearings, besides 500 of the sun, taken at proper hours to get true azimuths, each of these being followed by an angular zenith distance. I obtained three base-lines from differences of latitudes observed on two heights situated near the same meridian and connected by azimuths. The northern base is nearly 51 miles long; I got there my longitude by eight occultations of stars. The second base is 52 miles calculated from a quadrangle, and the southern base, still more indirect, reaches 51 miles. I have thus carried a continuous chain of triangles from the Red Sea to the frontier of Kaffa, a distance slightly greater than from Calais to Bayonne. These triangles, mostly with only two observed angles, have been checked here and there by latitudes and independent longitudes. I got the latter by a few occultations, but chiefly according to the Russian method of lunar observations. By this method I have calculated 857 positions in Ethiopia. They are given in my pages 423-440, the heights being obtained by a *supposed* coefficient for terrestrial refraction.

In my "Géodésie" (page 195) I give the first mention of Mount Wosho as *probably* Wosho, and the following page says, "flat mountain which I suppose (*que je prends pour*) Wosho." Page 438 points in No. 805 to a note (p. 448) which adds, "placé pur renseignements et par ces azimuts réitérés." This hearsay evidence is taken from a list of days' journeys between Bonga and Wosho (published in my "Géographie") without details. The profile of the mountain measured from Falle is given in the collection of sketches belonging to my 325 *tours d'horizon*. Moreover, the zenith distance was 90° 21′, nearly the very worst to be corrected by the ordinary rule for terrestrial refraction. In spite of all these drawbacks, I published the resulting enormous height in order to call attention to Wosho. Let us hope that some explorer, after throwing a net of triangles over Walamo, may put in its proper place and height the real Wosho.

ANTOINE D'ABBADIE.

Hendaye, December 13, 1895.—

I AM aware that M. d'Abbadie did not still maintain the exaggerated importance once attached to Mount Wosho, for which, indeed, he is by no means solely responsible. My remark was suggested by the fact that the great mountain reported by Grixoni's expedition had again called attention to Mount Wosho, and led to the idea that the earlier reports were possibly, after all, correct. But until Dr. Donaldson Smith's maps are published, it is no use attempting to reconcile the previous maps of this region. THE WRITER OF THE NOTE.

Cactaceæ in the Galapagos.

ALTHOUGH the Editor has kindly replied to that part of Mr. Agassiz's letter [*ante* p. 199] relating to the *Albatross* Expedition, I should like to say a few words on the other points raised by him. In the first place, I regret that my communication on the subject should have produced the impression of unfairness towards any person or persons. Such was not my intention. For the sake of my own reputation, as well as for the information of those who, like Mr. Agassiz, might, from my way of expressing myself, think otherwise, I may add that I did not intend to convey the idea that *Opuntia* and *Cereus* are limited to Chili on the west coast of America. The contrary is so well known, that it did not appear necessary to me to enter into particulars. Of course Mr. Agassiz will hold me guiltless of suppressing anything respecting the branches of *Opuntia* and *Cereus* which he says he collected, though he does not know what became of them.

Perhaps I may also be permitted to add that Dr. Baur has since sent me some very fine photographs of *Opuntia* and *Cereus*, on a comparatively large scale, together with some notes, which I laid before a recent meeting of the Linnean Society.

Herbarium, Kew. W. BOTTING HEMSLEY.

A Luminous Centipede.

IN Mr. Lloyd Bozward's letter on the above subject in this week's NATURE, he says that the light of the *Scolopendra electrica* "is the same as that of the glow-worm." My experience is that the light of the glow-worm is a clear little *spark* of light; whereas that of the *Scolopendra electrica* (which I have usually found in the autumn) is more of a phosphorescent light, and streaks of this light are left for a few seconds in the trail of the animal as it crawls about, so that it is often difficult to say exactly where the creature is. I have no doubt others have observed the same thing. T. PLOWMAN.

Enfield, N., January 11.

The Critical Temperature of Hydrogen.

WHAT I object to is not Mr. Bryan's reference to Wroblewski's work, but his statement (explicitly founded upon the absence of "fresh experiments") that my conclusions "are not results of independent original investigation." In his letter to NATURE of January 9, Mr. Bryan does not even attempt to justify this statement. My *Bulletin* paper was an abstract; in the full paper (*Trans. Crac. Acad.*, vol. xxvii. p. 375), published May 1895, Wroblewski's work was quoted and discussed.

Cracow University, January 12. L. NATANSON.

A Fog Scale.

CONSIDERING the important part that fog plays in determining the character of a health resort, it is remarkable that no

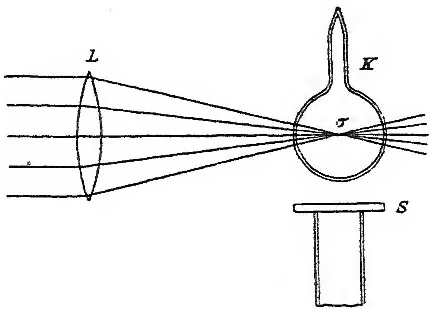
scale similar to those adopted for wind and cloud should have been hitherto used in meteorological reports. Like the above scales, it could only be approximative; but if observers fixed upon conspicuous objects, such as hills, churches, &c., at known distances for their observations, these ought to be at least as accurate as those for wind and cloud.

Nant-y-Glyn, Colwyn Bay. ALFRED O. WALKER.

FLUORESCENCE OF SODIUM AND POTASSIUM VAPOURS, AND THE IMPORTANCE OF THESE FACTS IN ASTROPHYSICS.[1]

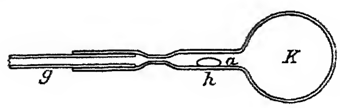
IN the case of unmixed vapours, E. v. Lommel (*Wied. Ann.*, p. 856, 1883) has proved a fluorescence for iodine vapour, and this has been shown also by us (*Wied. Ann.* 56, p. 18, 1895) to be true for the vapours of numerous organic substances. In our latest experiments we have studied the behaviour of the vapour of metals in this respect.

(1) *Order of Procedure.*—For the experiments the following arrangement was adopted. Rays of sunlight were made to fall on a double convex lens, L, of focal length 5 cm., which brought them to a focus at a point, σ, in the centre of a glass spherical bulb, K, filled with vapour.



To one side of the bulb was placed a spectroscope with the slit horizontal, the edge of the prism also being horizontal. The spectroscope was fixed by its legs on a board placed vertically, and could be revolved round its axis by means of a movable cone on the inside part of one of the feet. One was able also to adjust the collimating telescope on the cone of fluorescence proceeding from the inside of the bulb.

The bulbs, which were made principally of hard glass, were filled with sodium, potassium, and other metals in the following manner.



In the first place, a small quantity of the metal was placed in the bulb K, the neck then drawn out, and at its extremity connected with a tube of soft glass, leading to a mercury pump. The metal was then placed in position *a*, and warmed during continuous gentle pumping, in order to get rid of all water vapour and CO_2; each bulb was also several times cleaned out with hydrogen. The heating was then increased, and when a convenient quantity of the metal was distilled the tube was sealed off by means of the blowpipe. In most cases the diameter of the bulb was 5 cm., so that it could be easily enveloped in a flame. We have also employed bulbs made of soft glass and of various sizes, but the optical effects were exactly the same. Difficulties were met with when employing the alkali metals; for, as soon as the vapour began to be formed, the bulbs became browned and blackened, so that new ones had to be substituted.

(2) *Results.*—The experiments showed that the fluorescence of sodium and potassium vapour was bright—the former green, the latter intense red.

The fluorescence can also be beautifully seen by observing the vapours of these metals in the light of an arc lamp. In cases of the less volatile metals, we have not yet been able with perfect confidence to prove its presence, although the vapour of cadmium undoubtedly at the surface of the melting metal displayed a green fluorescence colour. The failure, however, of these experiments may be explained partly by the poor intensity of the rays of the winter sun. We shall, naturally, repeat them in summer.

The fluorescence spectrum of sodium vapour was made up as follows:

675.	Boundary of the red.
675—602·5.	Bright red band.
602·5—540.	Dark band.
540—496.	Green fluted band, composed of single dark and bright lines.

In the blue there is practically nothing visible.

At the less refrangible end of the dark band 602—540, the yellow sodium line appeared.

The appearance of the bright line of sodium was not caused by the presence of the flame used for heating, because when this was removed, the line remained still bright; nor could its presence be explained by the action of chemical processes taking place in the bulb, because the moment the incident light was cut off it disappeared.

The fluorescence spectrum of the vapour of sodium[1] is made up of three parts: (1) the non-fluted band in the red, (2) the fluted band in the green, (3) the bright sodium line in the yellow.

Whilst in the cases of solids and liquids which exhibit fluorescence the fluorescence spectra consist of broad ill-defined, continuous streaks, we meet here also fluted bands, as shown by other gases under the action of electrical discharges, and single lines.

The fluorescence spectrum of potassium displays at 695—615 an intensely red band.

Adjoining this band the dark interspace is relieved by the somewhat brighter appearance of the green, due, perhaps, to the presence of some sodium vapour.

The bright lines of potassium could not be proved, but their absence may be accounted for by the feeble intensity of the incident light.

The fluorescence spectrum of lithium could not be observed, because so soon as the lithium was placed in the bulb and heated, the glass exposed to the light-source became affected. By further heating, the vapour given off displayed only the green fluorescence light of sodium. For the same reason experiments to obtain in discharging tubes, the "elekroluminescenz" of lithium were unsuccessful.

(3) *Validity of Stokes' Law for the Fluorescence Light of Metallic Vapours.*—We have also made investigations to find out whether here the law of Stokes—that is, whether the *excited* rays of light are less refrangible than those *exciting*—holds good. To this end a spectrum was formed by means of a prism, but only a small strip of this was employed, and led by means of a lens into the bulb filled with vapour. In the case of the vapour of sodium the intense green light radiated was excited, in

[1] Translation of a communication to the "Sitzungsberichten der physikal. med. Societät zu Erlangen." By Eilh Wiedemann and G. C. Schmidt.

[1] A comparison of these fluorescence spectra with that which is obtained by the heating of sodium vapour exhibits certain relations (Evershed, *Phil. Mag.* (5), 39, p. 460, 1895); the same is the case with both sodium and potassium, if the positions of the fluorescence spectra be compared with the absorption-band-spectra investigated by H. E. Roscoe and A. Schuster (*Proc. Roy. Soc.* London, 22, 262, 1894). In both cases the radiation towards the red appears altered.

the first place, by the green-blue rays; and the red by the yellow and red rays. Potassium, when excited by red light, emitted light of a deep red colour.

These experiments show that at least no very marked deviations from Stokes' law exist.

(4) *Applications to Astrophysics.*—We wish to point out in a few words the importance, for astrophysical problems, of the preceding observations concerning the fluorescence of the metallic vapours.

We know that in the atmosphere of the sun there exist vapours of different metals which are radiated from the sun; these must also exhibit fluorescence, and that of a bright nature. We must also remember that the intensity of the exciting light in the region of the sun is much greater than that near the earth's surface, and also the same may be said of that of the fluorescent light. These rays of fluorescence do not follow Kirchhoff's law.

The radiated fluorescent light is made up of coninuous and fluted bands and single lines. By mixing several metals together the continuous bands grouped themselves and formed a continuous spectrum, the delicate, and sometimes less recognisable, fluted bands, however, of several substances neutralised each other, and so became invisible. Each of the sharp lines, on the other hand, remained visible. We have thus, for example, a very simple means of explaining the spectrum of the corona, which consists of a continuous spectrum and single bright lines. It is then unnecessary to assume that luminosity is produced by a continuous agitation depending on electrical oscillations; agitations which, nevertheless, play in many cases an important part. Applications of these results may also be found to be closely related to the theory of the chromosphere, certain forms of prominences, &c.

In all astrophysical and other light phenomena (*Strahlungserscheinungen*) special discussions will be necessary, not only from the point of view as to which portions of the ray are the result alone of an increase in temperature, and which depend on "luminiscence" (*luminescenz*), but it must be especially made clear when we have before us "photo-luminescence" and when "fluorescence." In this case the conditions are relatively simple, and for experiment easily accessible.

(5) *General Remarks.*—The case of the fluorescence of rarefied vapours of potassium and sodium as investigated by us, might be the simplest possible when once the light-producing molecules of the vapourous body under investigation are almost uninfluenced by the action of its neighbours, if we disregard the short spaces of time during which two or more molecules occupy in their respective reactions. Then they behave just like the molecules in bodies of a solid and liquid nature.

Further, the vapours of sodium and potassium consist of single atoms (*einatomig*), so far at least as can be judged from vapour densities established up to the present. The fact, that in these vapours not only band- but also line-spectra make their appearance, necessitates, for the theoretical investigation of fluorescence, the adoption of a new point of departure, more especially if the fundamental movements of the molecules among themselves in fluorescence be investigated.

(6) *Result.*—The fluorescence of sodium and potassium vapours is bright; the former green, the latter red. In the fluorescence spectrum of sodium vapour continuous and fluted bands appear, in addition to the bright sodium line.

Stokes' law is probably valid for the fluorescence of the vapours of metals. The fluorescence of the vapours of metals gives a means of explaining a series of astrophysical phenomena.

(Experiments with helium and argon are in process of investigation.)

NOTES.

M. CHATIN has been elected the new Vice-President of the Paris Academy of Sciences, in the place of M. Cornu, who has passed on to the presidency.

THE French Government has paid a graceful compliment to Prof. Virchow, by nominating him Commander of the Legion of Honour.

THE United States Congress has already made a good beginning as to matters scientific and educational. One of the first subjects to which attention was called, after the opening of the current session, was the proposed joint meeting of the three associations of English-speaking people for the advancement of science, at San Francisco in 1897, namely the Australasian, American and British, following the Toronto meeting of the British Association. A Congressman from Brooklyn presented a memorial and petition from one of the original Fellows of the American Association, setting forth the plan for such a meeting of these associations, and requesting aid from Congress to put the American Association on equal footing with the British in regard to transportation of members across the continent, which it is supposed that the Canadian Pacific Railway will furnish nearly or quite free to the latter. The same member a few days later introduced a resolution in favour of the metric system. Should the three science associations succeed in holding a joint meeting, this subject would well deserve careful consideration.

TWO appeals for funds to fit out Polar expeditions have lately been made—one for support of Captain Jackson's scheme for the exploration of the North-East passage, the other for means to equip a British Antarctic expedition. Captain Jackson proposes to determine whether the North-East passage from Europe to China and America is really practicable to merchant vessels properly fitted for the Northern Seas, and to make as many scientific observations as the equipment of his expedition will allow. If he cannot obtain funds to purchase and equip a suitable ship, he announces his intention to proceed to Polar regions in his yacht *Venture*, a boat only thirty-seven feet long. The Honorary Secretary of the Committee that appeals for support on behalf of Captain Jackson's scheme is Mr. E. R. Suffling, Blomfield Lodge, Portsdown Road, London, W.

THE Executive Committee for the British Antarctic Committee hope to obtain £5000 to be expended on outfits and supplies for twelve scientific men to spend a year in South Victoria Land. It is proposed that these investigators shall be conveyed to Cape Adair by a commercial expedition now being formed with the object of operating near Victoria Land. The party is expected to leave on September 1 next. After calling at Melbourne they will sail direct to Cape Adair, which, under favourable circumstances, should be reached in about fourteen days. There they will be landed with their outfit and instruments, and remain for one year, after which period they will be called for and brought back by the commercial party. The following is a general plan of the proposed investigations to be carried on at Victoria Land by the scientific members of the expedition: (1) A land party will work towards the South Magnetic Pole, there to make magnetical observations. (2) The coast-line of the open bay will be surveyed, fjords and bays explored and sounded. (3) Zoological, botanical, mineralogical and geological collections will be made. (4) Dredging. (5) Barometrical, thermometrical, meteorological and pendulum observations. (6) Air and water current observations. If this programme is only carried out in part, valuable additions to scientific knowledge will undoubtedly be obtained. There are many who are eager to labour in the

unexplored fields of the Antarctic, and already a considerable proportion of the sum required to enable them to do so has been promised. All who are interested in the advancement of Antarctic researches are invited to send subscriptions to the Chairman of the Executive Committee, Royal London Yacht Club, 2 Savile Row, London, W.

MEMBERS of the engineering profession, who believe in the progress of industries through science, will be interested to learn that, according to *Science*, a movement is in progress, in the United States, having for its object the development of a system of mechanical engineering "experiment stations," on much the same basis as the existing agricultural experiment stations. It is anticipated that the outcome will be the organisation of such stations in all the agricultural and mechanical colleges of the country in which the agricultural experiment stations have been successfully organised and operated. The purpose of the movement is to secure the promotion of engineering research, and of the development of the scientific facts and principles which are of most value to the mechanical arts and to the profession of engineering. The headquarters of the central office, to which all will report, is thought likely to be the Bureau of Steam Engineering of the Navy Department; that being the largest, most important, and most generally suitable of the Government Bureaux to take cognisance of such work as is contemplated. A Department of Mechanical Arts was proposed years ago, probably earlier than the Department of Agriculture; but the importance of the former has not been as promptly or as fully recognised as that of the latter, and nothing has yet been done in that direction. Should such a department be founded, it will naturally become the centre of the work of mechanical engineering experiment stations.

A BILL "to establish the University of the United States," was recently introduced simultaneously in the United States Senate and House of Representatives. It provides for the representation at all times of twelve other institutions of the United States in the educational control of the National University. A National University Committee of one hundred has been formed, embracing the Chief Justices of the United States, ten ex-United States senators, certain ex-United States ministers and governors especially interested, the presidents of a number of colleges and universities, the State superintendents of thirty-seven of the States, and the heads of leading national organisations, scientific and patriotic, together with the chiefs of the Government bureaus at Washington. The measure provides for that higher instruction only which follows the work of graduate institutions, and for the induction of students of post-graduate rank into the many fields of original work in research and investigation. The business affairs are to be managed by a board of sixteen regents, with the President of the United States at its head, six members being such *ex officio*, and the remaining nine to be appointed by the President with the consent of the Senate. The educational officers are to be managed by a university council, composed of the regents, acting jointly with twelve eminent educationists representing as many leading institutions of as many States, holding office, like the Regents, for six years, and appointed on the principle that each of the States may in time have representation. The University is authorised to establish such co-operative relations with other institutions as shall be deemed advantageous to the public interests. Neither partisan nor sectarian preferences are to be allowed in any form. Admission is to depend on competency only. The Bill provides for only a few thousand dollars in each of the years 1897 and 1898, to enable the regents to organise, and for the necessary preliminary work.

IT is stated that the New York Pasteur Institute has purchased a farm of about two hundred acres near Tuxedo Park, to be used as an experiment station.

THE storm that visited New York on December 26–27 was attended by the most violent wind ever recorded there. A wind velocity of eighty miles an hour was noted.

MR. JOHN DONNELL SMITH is again in Nicaragua in pursuance of his botanical explorations, which have already been so fertile in additions to the Central American flora.

WE regret to notice the deaths of Prof. Teichmann, formerly Professor of Anatomy and Physiology at Cracow; and of Mr. Hugh Miller, Geologist on the Geological Survey of Scotland, and author of several geological memoirs.

THE vacancy in the Curatorship of the South African Museum, Capetown, caused by the retirement of Mr. Roland Trimen, F.R.S., has been filled by the appointment to that office of Mr. William L. Sclater, Assistant Master of Eton College, and Curator of Eton College Museum. Previously to his present appointment at Eton, Mr. Sclater was for several years Deputy Superintendent of the Indian Museum, Calcutta.

M. R. SCHLECHTER is intending shortly to start on a two years botanical exploration of the South and East of Africa. His programme includes a prolonged stay in Namaland, the Transvaal, Coud-Bockeveld, Limpopo, and Matabeleland as far as the Zambesi. Subscriptions for his collections will be received by Prof. Schumann, Botanical Museum, Grünewaldstrasse, Berlin. They will be at the rate of 35 marks the hundred.

MR. GEORGE W. VANDERBILT is establishing, on his estate at Biltmore, in North Carolina, a scientific collection of dried plants in connection with an arboretum and scientifically managed forest. As a nucleus he has recently purchased, as we learn from the *Botanical Gazette*, Dr. Chapman's herbarium of Southern American plants, which formed the foundation for his "Flora of the Southern States."

THE Fishery Board for Scotland has been reconstituted in accordance with the Sea Fisheries Regulation (Scotland) Act of last Session. Mr. A. Sutherland is reappointed chairman, Mr. R. W. Cochran Patrick is appointed deputy-chairman, Mr. Donald Crawford legal member, and Dr. John Murray scientific member. The other members are Mr. J. R. Welch, Dr. W. R. Duguid, and Mr. A. Jameson.

A REUTER telegram from Stockholm states that, at the instance of the Ministry for Foreign Affairs, notice has been sent to the Governments of Russia, Denmark, Great Britain, and the United States, of S. A. Andrée's projected balloon voyage to the North Pole, and co-operation asked for on behalf of the expedition. Furthermore, the authorities in the countries surrounding the Polar circle will be invited to distribute some thousands of leaflets, containing illustrations of the balloon, and asking for information as to the time at which the balloon is seen, and the direction of the wind at the moment.

ACCORDING to a Reuter telegram from Teheran, there have been two severe earthquakes in Khalkhal, north of Miana. The first occurred during the night of January 2. It was not felt outside the district, but completely destroyed the large village of Zanjabad and partially destroyed several other villages. Three hundred persons lost their lives. The second shock occurred early on the morning of the 5th inst., and was very severe, being felt more than a hundred miles away. The small town

of Goi was completely destroyed, 1000 houses being laid in ruins, while great damage was done to many villages. The loss of life in Goi alone amounted to 800 persons. A sharp earthquake disturbance was also felt at Meshad and Kelat at 10.50 on the morning of January 8.

DURING last week an anti-cyclone lay over the British Islands, during which the barometer read higher than had probably been recorded before in this country. The *Daily Weather Report* issued by the Meteorological Office on the 9th inst. showed a barometer reading of 31·09 inches at Ardrossan, in the West of Scotland, and the readings over the whole of the northern and north-western parts of the kingdom reached or exceeded 31 inches. The nearest reading to this occurred in January 1820, again on the 9th, when the barometer in Scotland rose to 31·06 inches; which until now had been considered to be the highest on record in the British Islands. In January 1882, a reading of 30·99 inches was recorded in the South of England.

WE owe the following news to Mr. R. H. Scott, who received it from Caherciveen. "On Monday night, January 6, at about half-past seven o'clock, a large meteor fell from the sky and approached the earth from a north-east direction. As it approached near the earth with accelerated velocity, brilliant sparks or particles were shot out from it in all directions. The whole country was brilliantly illuminated for about ten seconds, that is, during the time occupied by the meteor in its descent. When the meteor was apparently within about two hundred yards of the earth, it burst or exploded, and the increased illumination was most remarkable. It was impossible for a person to estimate, even approximately, the place or neighbourhood where this meteor fell. Different persons, viewing it from various standpoints, give different locations, but they all agree that the descent was westward or seaward of this locality. The meteor was, apparently, of a globular form, with a tail about eight times as long as the diameter of the globular portion. All was of the same brilliant radiance, but a few seconds before the end of the fall, or when the meteor was extinguished, the half of the tail furthest away from the body became black."

THE Swiss National Exhibition begins at Geneva on May 1 and terminates October 15. Mr. Theodore Turrettini, Mayor of Geneva, is president of the exhibition, and it is expected that the electrical exhibit will be remarkably good. Mr. Turrettini has recently completed great engineering works near Geneva, whereby the river Rhone supplies 12,000-horse power, to be electrically transmitted six miles to the grounds. This power makes it possible for elaborate electrical works to be shown. There will be a travelling footpath, operated by electricity, traversing the great machinery hall; horseless cabs driven by electricity, appliances for aerial navigation, a multiplying valve-pump, processes for making paper and fabrics, tests of strength on metals, and many other appliances. Prof. Pictet will exhibit his apparatus for producing intense cold, and will demonstrate the uses of very low temperatures. Numerous other exhibits of scientific interest will be shown.

PROF. W. C. RÖNTGEN, Professor of Physics in Würzburg University, is reported to have discovered that a number of substances which are opaque to visible rays of light, are transparent to certain waves capable of affecting a photographic plate. It is alleged that he has been able to utilise his discovery to photograph metals enclosed in wooden or woollen coverings, and has succeeded in obtaining pictures showing only the bones of living persons; the explanation being that, while wood and flesh freely allow the newly-discovered actinic rays to pass through them, bones and metals are opaque to them. So far as we can gather from the reports, Prof. Röntgen uses as his source of light one of Mr. Crookes' high-vacuum tubes, electrically excited. If this is placed on one side of a box containing a metallic body, or if a hand is held in front of it, and a sensitive plate is arranged on the opposite side, a photograph of the metal, or of the bones of the hand, as the case may be, is obtained. The scientific world will look forward with interest to the publication of the details of Prof. Röntgen's work.

THE old question as to the influence of public libraries in disseminating infection is commented upon by the *British Medical Journal*, in the current issue. It is pointed out that an article in the last number of the *Annales de l'Institut Pasteur*, by Du Cazal and Catrin, is devoted to this question, and it is shown that the leaves of book soiled by streptococcus pus, pneumonic pus, and expectoration, or by diphtherial false membranes, were capable after several days of transmitting these maladies to animals inoculated by bouillon in which pieces of the leaves 1 centimetre square had been soaked. In regard to the question how far it is possible to disinfect books that have become charged with a contagium, these authors show that there are considerable difficulties in the way. Of chemical disinfectants they recommend the vapour of formic aldehyde in which calcium chloride has been dissolved. By means of this they obtained complete disinfection, except in regard to typhoid fever. By exposure to high-pressure steam, however, they got good results—the disinfection was perfect and complete. But in the case of bound books the steam had very destructive effects, the millboard being softened and the cloth wrinkled. Stitched books, however, were uninjured, no harm being done either to the paper, the ink, or even to coloured engravings.

IT speaks well for the extension of interest in science that steamships are advertised to proceed from London with passengers to view the total solar eclipse from Vadsö, in the Varanger Fjord, on August 9. The conditions of 1851, when a small expedition observed a total eclipse from Bue Island, Norway, has given place to a new state of things; and there seems every possibility that for every one who went out to see the obscuration of the sun then, fifty will witness the phenomenon next August. The Orient Steam Navigation Company will send out two of their steamships; Messrs. Cook and Son have made arrangements for special eclipse cruises; and Messrs. Gaze and Son announce a trip to Vadsö in the *Norse King*. This steamer is due at Vadsö on August 3, which leaves sufficient time for the average sightseer to settle down to a frame of mind suitable for observing a solar eclipse. But we notice with some astonishment, in a circular issued by Messrs. Gaze and Son, the statement that "an official party of observers, arranged by a joint committee of the Royal Society and of the Astronomical Society, are proceeding to Norway, and will travel by the s.s. *Norse King*." We can hardly think that this statement is authoritative, for scientific committees are not in the habit of advertising their intention to patronise any particular line of steamers; and, further, astronomers usually require more than five days to adjust and set up their instruments, if any work of real use to science is to be done. Of course, those photographers who merely wish to take snap-shots at the corona do not need to make any elaborate preparations, and if the steamship they travel by carries them into harbour two or three days before August 9, they will have ample time to point their cameras correctly.

IN a short note contributed to the Paris Academy of Sciences on December 30, Prof. Suess calls attention to the striking geographical results of the researches of his Vienna colleagues on the marine Triassic fauna. While to English geologists the Trias is the typical example of an unfossiliferous land-deposit, the work of Mojsisovics on the contemporaneous deposits of the Alpine region has been the starting-point for a series of dis-

coveries in many parts of the world. A rich marine Triassic fauna is now known extending from Spain to Japan and California, and from Spitzbergen to New Zealand. Yet among the thousands of these fossils gathered together in Vienna from all parts, there is not a single marine fossil from the regions bordering the Atlantic or Indian Oceans. The conclusion is obvious, that the regions of these modern oceans were not covered by sea in Triassic times. On the other hand, all the districts bordering the Pacific and Mediterranean yield the marine forms, as does a great stretch of land extending from the Mediterranean to the Pacific through Central Asia, and another extending from the Pacific through Eastern Siberia to the Arctic Ocean. Thus the Pacific Ocean was the main ocean in Triassic times, and stretched out two arms across the continental region—the one called the *Tethyan* ocean, of which the Mediterranean is the last remnant, the other the Arctic branch. This distribution of the Triassic seas strikingly agrees with that of the structural features of modern coast-lines indicated by Neumayr: the oceans bordered by lands with marine Trias are the oceans of the *Pacific type*, of which the coasts are determined by the convex margins of earth-folds; while the oceans of *Atlantic type*, of which the margins cut across the mountain-folds, are those around which only the fresh-water Triassic strata are found. Thus is confirmed the opinion that the latter oceans are of comparatively recent origin, and have been produced by a process of wholesale depression, which has cut out the three great triangular upstanding masses (or *horsts*) of Greenland, Africa, and India, which form so striking a feature on the surface of our planet.

The Geological Survey has generally been successful with its index maps, and the beautiful hand-coloured index of Wales, on the scale of four miles to an inch, has a great reputation for correctness of topography, clearness and accuracy of colouring, and beauty of appearance. After the lapse of a long period, the Survey, about two years ago, began the issue of an index map of England and Wales on the same scale, and of this several sheets have been already issued. These sheets were also coloured by hand; but on account of their complicated structure they were necessarily very expensive to produce, and hence, although sold with the barest possible margin of profit, or, indeed, with none at all, they could never become very widely used in consequence of their high price. Now, however, an important experiment has been tried, the issue of Sheet 12 printed in colours. This map includes the London Basin and the greater part of the Weald, and it is identical with the hand-coloured sheet; but whereas the price of the latter was 10*s*. 6*d*., that of the former is 2*s*. 6*d*. Printing the map in colours brings with it practically no disadvantage. The topography is clear and correct, the latest railways being inserted; the colours are transparent, clean, harmonious, and well-defined; each colour is lettered at all critical points; the registration is wonderfully exact, although such minute delineation is a very severe test of the workmanship; and the detail is quite as full as on the hand-coloured map, which, it will be remembered, contained many revisions not as yet shown on the original 1-inch sheets. On the other hand, printing in colours has two inestimable advantages, which those familiar with the hand-coloured maps will realise to the full; the inevitable omissions of the colourist will disappear, and, as the colour-proofs come to hand, there is every encouragement for the makers of the map to exercise the minutest care in delineations of details, which, once inserted, cannot again drop out by accidental omissions of the draughtsman, engraver, or colourist. It is to be hoped that this is only the beginning of good things, and that the Survey will persevere until it has the rest of the index similarly printed, thus providing an unequalled and authoritative map of the whole country. If this is successful, we cannot stop here, but must look forward to having reproduced by colour-printing at least such of the 1-inch sheets as are sufficiently used to justify the expenditure. Indeed, it would doubtless be wisest, and really cheapest in the end, to undertake this course with all the sheets of the new series as they come out, irrespective of the demand upon each particular one. If these could be produced at the price of 1*s*., instead of 4*s*., a brisk demand would be at once created. The public must, however, do its share. We have already stated that the index-sheet is issued as an experiment. If the issue is well supported, this will furnish a great encouragement to the Stationery Office to follow the good course it has begun.

A graphic method of determining the focal lengths of lenses and mirrors is described by Dr. E. H. Barton in the *Philosophical Magazine*. For a concave mirror, cut off the distances of the object and the image respectively on the two axes of Cartesian coordinates, and join the two points. Two separate observations will give two lines intersecting in a point equidistant from the two axes. The coordinates of this point are both equal to the focal length required. The measurements may be controlled by another observation, and the line now obtained should intersect the other two in the same point. A line passing through this point and rotating about it will cut off in succession all the possible values of the conjugate focal distances. For a convex lens, the point is situated in the right hand lower quarter, for a convex mirror in the left-hand lower, and for a concave lens in the left-hand upper quarter of the plane of coordinates.

On no other frequented trade route are vessels so liable to be obstructed by drift ice as in that portion of the South Atlantic lying to the east of Cape Horn and the Falkland Islands. A chart just issued by the U.S. Hydrographic Office, to show the limits of the enormous ice fields encountered by mariners in those waters, will therefore be of great service. The chart also gives for the months of March, April, and May the isotherms or lines of equal temperature of the surface water. It is stated, however, that these lines are of doubtful value to the navigator in announcing the proximity of ice, as practical experience has shown that the temperature of the surface is little affected thereby. The report of Captain Macmillan, of the ship *Dudhope*, is especially interesting in this connection: "Careful thermometric observations of air and water were regularly taken, but our approach to ice, always from windward, was not once indicated by any appreciable change of temperature, in either air or water. On passing to leeward of the bergs, a fall of a few degrees was generally observed *in the air*. On one occasion we passed within a cable's length of a berg, and found the temperature to be the same there as at several miles' distance. This would go to show that in thick weather—or in any other—even temperature and thermometer at normal height should not be accepted as a trustworthy guarantee of immunity from ice. Care and a most vigilant look-out are the only trustworthy safeguards. To depend on the thermometer would mean disaster, as I am convinced that a ship would be too close to the ice to extricate herself by the time the thermometer would indicate its presence."

Recent progress in the chlorination process for the extraction of gold from its ores lies mainly in the direction of improvements in the mechanical appliances which are used. The repeated efforts to prevent the oxidising action exercised by chlorine on the unroasted sulphides in ores, by adding salts such as nitre to the mixture, have now apparently been abandoned. Most chemists have always regarded the hopes of the experimenters in this direction as chimerical. Among the mechanical improvements of the last year have been the enlarging of the lead-lined steel barrels used in Western America. As now made, these

barrels take a charge of ten tons of ore, instead of only five. The filter inside the barrel is retained, but the expensive asbestos cloth, which lasted for only a few charges, is replaced by a cheap sand-filter, which, it is stated, is not shifted by the rotation of the barrel, and does not become clogged until after it has been used for about 100 charges, or say a month. While the Americans are thus engaged in perfecting the barrel process, the Australians have abandoned it altogether. At the Mount Morgan Mine, where there is the largest chlorination plant in the world, the vats have been reintroduced, but are much enlarged, each having a capacity of twenty-five tons. Chlorine water is used, the consumption of chemicals being less, and the reagent more under control than if gas is pumped into the charge. The use of bleaching powder and sulphuric acid for generating the gas has been superseded again by manganese dioxide, salt and sulphuric acid, and the installation of chlorine stills, towers, and solution tanks. The extraction of gold at Mount Morgan is about 95 per cent. of the total amount in the ore, and the cost of treatment, now about 15*s.* per ton, is expected to be reduced to 12*s.* per ton by the more extended use of revolving furnaces. The total production at the mine is at the rate of over 100,000 ounces of gold per annum. The impetus given to the barrel chlorination process a few years ago seems, from the above facts, to have spent its force.

THE *Bulletin* of the Kansas Experimental Station records instances of the poisoning of cattle by eating the stalks of Indian corn, from the very large amount of potassium nitrate which they contain.

OUR attention has been drawn to two laborious investigations by E. Mazelle, of the Trieste Observatory, recently presented to the Vienna Academy of Science, relating to the daily and yearly range of variability of temperature, and to the relations between the usual mean value and the "most frequent" values of temperature, as deduced from the records of fifty years, 1841–90. The difference between the mean and most frequent values has been discussed by various authorities, notably by Dr. J. Hann in the second edition of his "Climatology." The observations for each month, or year, are grouped so as to show how often a certain value, or interval of temperature occurs, and from these a curve is drawn which differs, according to circumstances, from one showing the mean values, and, while not superseding the latter, is of considerable interest for comparison with it. For various interesting details we refer our readers to the original papers.

THE third edition of M. Faye's "L'Origine du Monde' (Gauthier-Villars, Paris) has lately been published. In this volume M. Faye states and discusses various theories and beliefs held as to the mode of the genesis of worlds, from the Mosaic record to the views of Kant and Laplace, and of their successors. Within the past ten years much work bearing upon the evolution of worlds has been done. Long-exposure photographs of nebulæ have given astronomers more information upon cosmical genesis than all that was known before their era, and photographs of spectra have enabled spectroscopists to arrange celestial objects in order from the youngest to the oldest. We naturally turned to the new edition of M. Faye's book expecting to find the work of recent years set down with the fulness which it deserves. But we were disappointed. Instead of a picture of Dr. Roberts' photograph of the Andromeda nebula, there appears a venerable cliche which ought to be banished from every book that pretends to represent astronomical knowledge of to-day. The same remark applies to the picture and the spectrum of the Orion nebula, of the spectrum of Sirius, and to most of those in the volume. When the first edition of the book appeared, such illustrations might have passed muster; but in these days of abundant photographs and cheap process-blocks, there is no excuse for offending the sight with them. We cannot see any difference between the third edition of M. Faye's book and the first edition, as regards illustration, and little difference as regards the text.

THE additions to the Zoological Society's Gardens during the past week include a Persian Gazelle (*Gazella subgutturosa*, ♂) from Persia, presented by Mr. F. Greswolde-Williams; two Polecats (*Mustela putorius*, ♂ ♀), British, presented by Mr. A. H. Cocks; a Yellow-fronted Amazon (*Chrysotis ochrocephala*) from Guiana, presented by Lieut.-General Arthur Lyttleton-Annesley; two West African Love-Birds (*Agapornis pullaria*) from West Africa, presented by Mrs. Otto Fell; a Crowned Duyker-Bok (*Cephalophus coronatus*, ♀) from West Africa, two King Penguins (*Aptenodytes pennanti*) from the Macquari Islands, purchased.

ERRATUM.—In the article on "The Habits of the Cuckoo" (p. 176), for Dr. Reh read Dr. Rey.

OUR ASTRONOMICAL COLUMN.

HIND'S VARIABLE NEBULA.—Further confirmation of the variability of the nebula N.G.C. 1555, discovered by Dr. Hind in 1852, has been obtained by Prof. Barnard (*Monthly Notices*, vol. lvi. p. 66). It may be remembered that so recently as February 1895, the nebula was an easy object in the Lick telescope, while Struve's nebula, in the immediate neighbourhood, was absent, and the nebulosity round τ Tauri was imperceptible (NATURE, vol. lii. p. 180). Under the very best conditions of observation in September last, however, Hind's nebula seemed to have entirely vanished, although every means was tried to see it. This appears to definitely prove that the light of the nebula fluctuates, and it is therefore desirable that the place of this object should receive careful attention. τ Tauri was involved in a small hazy nebulosity, but the definite nebula in which it shone in 1890 did not exist four months ago.

o CETI.—The last two or three maxima of this well-known variable star have occurred considerably later than the computed times, and the present, or perhaps approaching, maximum is similarly behindhand. According to the ephemeris in the *Companion to the Observatory*, there should have been a maximum on December 9, but on January 8, the star had barely reached 4th magnitude. The star is now much more favourably situated for observation than during several preceding maxima; and, in view of the irregularity to which reference has been made, it is important that the magnitude should be recorded as frequently as possible. Spectroscopic observations will also be valuable, and it may not be out of place to suggest a special look-out for bright lines of helium and the associated gases, as well as observations of the varying relative brightness of the carbon fluting slightly more refrangible than the *b* group of magnesium.

STELLAR VELOCITIES WITH OBJECTIVE PRISM.—The great advantages of the objective prism over the slit spectroscope for photographing the spectra of stars have been abundantly demonstrated, but hitherto the latter form of instrument has been considered essential for precise determinations of velocities in the line of sight. An adaptation of the objective prism for the latter purpose is proposed by M. Deslandres (*Observatory*, January). In the arrangement suggested, the collimator of an ordinary spectroscope is placed in a direction perpendicular to the rays proceeding from the star, and the light passing through the slit from the comparison spark is reflected upon the objective prism by a small totally-reflecting prism. The collimator, objective prism, and photographic telescope, thus constitute a complete slit spectroscope. With the aid of the auxiliary visual telescope, the spectrum of the star is photographed with the objective prism in the ordinary way, and during the exposure the terrestrial spectrum is photographed nearly alongside that of the star, the adjustments having been so made that lines of equal refrangibility in the two spectra are in the same straight line. The spectrum of a star with which a comparison of velocity is desired, or may be that of the same star after an interval, is then photographed adjacent to the first, with the help of the visual telescope; and another terrestrial spectrum is photographed alongside the previous one, a different part of the

slit being exposed to the spark. This comparison of terrestrial spectra enables the errors due to temperature and flexure to be determined, and the difference of velocity of the two stars is given by the displacement of the two stellar spectra minus that of the two terrestrial. Evidently the accuracy will depend very largely upon the precision in setting the two stars in the visual telescope; to secure this it is proposed to attach a small photographic telescope to the guiding telescope, and to photograph the two stars, together with a reticule, which will enable the deviation, if any, to be measured and allowed for. To get the absolute velocity of a star, it must be compared with a star of known velocity, or Orbinsky's method (NATURE, vol. lii. p. 155) of measuring the contraction or dilatation of the whole spectrum may be applied. In the latter case, the absolute velocity could be determined directly, since effects of temperature, &c., would be eliminated.

A NEW STAR IN CENTAURUS.[1]

A NEW star in the constellation Centaurus was found by Mrs. Fleming on December 12, 1895, from an examination of the Draper Memorial photographs. Its approximate position for 1900 is in R.A. 13h. 34·3m., Dec. − 31° 8′. Attention was called to it from the peculiarity of the spectrum on a plate taken at Arequipa on July 18, 1895, with the Bache Telescope, exposure 52 mins. The spectrum resembles that of the nebula surrounding 30 Doradus, and also that of the star A.G.C. 20937, and is unlike that of an ordinary nebula or of the new stars in Auriga, Norma, and Carina. This object is very near the nebula N.G.C. 5253, which follows 1·28s., and is north 23″. No trace of it can be found on 55 plates taken from May 21, 1889, to June 14, 1895, inclusive. On July 8, 1895, it appeared on a chart plate, and its magnitude was 7·2. On a plate taken July 10, 1895, its magnitude was also 7·2. On December 16, 1895, a faint photographic image of it, magnitude 10·9, was obtained with the 11-inch Draper Telescope, although it was very low, faint, and near the sun. On this date, and on December 19, it was also seen by Mr. O. C. Wendell with the 15-inch Equatorial as a star of about the eleventh magnitude. An examination with a prism showed that the spectrum was monochromatic, and closely resembled that of the adjacent nebula. Although the spectrum is unlike those of the new stars in Auriga, Norma, and Carina, yet this object is like them in other respects. All were very faint or invisible for several years preceding their first known appearance. They suddenly attained their full brightness and soon began to fade. Like the new stars in Cygnus, Auriga, and Norma, this star appears to have changed into a gaseous nebula.

The star which was photographed in 1887 in the constellation Perseus apparently belongs to the same class. Its approximate position for 1900 was in R.A. 1h. 55·1m., Dec. + 56° 15′. Eight images of it were obtained on the Draper Memorial photographs in 1887, all in exactly the same place. Its photographic spectrum showed the hydrogen lines $H\beta$, $H\gamma$, $H\epsilon$, and a line near 4060, bright, and from this property it was discovered by Mrs. Fleming and assumed to be an ordinary variable star of long period. The spectrum is so faint that it is impossible to decide from it whether it should be regarded as a new star of the class of Nova Aurigæ, or as a variable star of long period like *o* Ceti, as the hydrogen lines are bright in both these classes of objects. This star soon faded away and does not appear on 81 photographs taken during the last eight years. It has also been repeatedly looked for in the sky without success. No trace of this star appears on two photographs taken November 3, 1885, and December 21, 1886.

A list of the new stars hitherto discovered is given in the annexed table. Some changes would occur in it, if changes were made in the definition assumed for this class of objects. Early observations of several objects frequently called new stars, but which may have been comets, and whose positions are uncertain, have not been included. The stars T Bootis and U Scorpii have not been included, although they also may be new stars, as only one appearance of each has been noted. The name of the constellation is followed by the right ascension and declination for 1900, and the greatest brightness. The year of appearance is followed by the name of the discoverer; or, in the case of the earlier stars, of the principal observer.

[1] *Harvard College Observatory Circular*, No. 4.

NEW STARS.

Constellation.	R.A. 1900.	Dec. 1900	Mag.	Year.	Discoverer.
	h. m.	° ′			
Cassiopeia	0 19·2	+63 36	−5?	1572	Tycho Brahé
Cygnus	20 14·1	+37 43	3?	1600	Janson
Ophiuchus	17 24·6	−21 24	−4	1604	Kepler
Vulpecula	19 43·5	+27 4	3	1670	Anthelm
Ophiuchus	16 53·9	−12 44	5	1848	Hind
Scorpius	16 11·1	−22 44	7	1860	Auwers
Corona Borealis	15 55·3	+26 12	2	1866	Birmingham
Cygnus	21 37·8	+42 23	3	1876	Schmidt
Andromeda	0 37·2	+40 43	7	1885	Hartwig
Perseus	1 55·1	+56 15	9	1887	Fleming
Auriga	5 25·6	+30 22	4	1891	Anderson
Norma	15 22·2	−50 14	7	1893	Fleming
Carina	11 3·9	−61 24	8	1895	Fleming
Centaurus	13 34·3	−31 8	7	1895	Fleming

THE ETHNOLOGY OF THE BRITISH UPPER CLASSES.

IN "L'Anthropologie," tome v. (1894) Dr. Beddoe has published the results of his work on the cephalic index of the inhabitants of Great Britain and Ireland. Part of his work deals with the cephalic indices of the Cambridge undergraduates, which were placed at his disposal by J. Venn, F.R.S. He has also inquired into their height and weight, classing them in accordance with their place of origin; but he has taken no account of the colour of the eyes of these undergraduates, and so I thought it would be as well to continue his researches, now that there is more material to hand, paying especial regard to the colour of the eyes. It will be seen by a glance at the table appended that it is in a mere fraction of the total number that the eyes are described as "light." This is due to the standard of comparison afforded by the Anthropometrical Committee of the Cambridge Philosophical Society, and is a disadvantage which does not apply to the dark eyes, and it is therefore by confining our attention to the percentages of the dark eyes in the various groups that we get our best results.

I have examined, through the kindness of Dr. Venn, some 1400 more instances since Dr. Beddoe published his results in "L'Anthropologie." In the three special cases of cephalic index, height and weight, where my results are only a continuation of Dr. Beddoe's, I have, in the following table, incorporated his results in mine, so as to gain the advantage of having a larger number of instances to deal with. On glancing at the figures below, one is at first inclined to think that the upper classes of the various races, which have given rise to the present population of Great Britain and Ireland, have entirely fused with one another, as the differences between their respective indices are but small; but the following two points indicate, I think, that the fusion is still incomplete:—

(1) *Stature.*—The Welsh are about ·8 inch shorter than the English, and as much as 1·5 inches shorter than the Scotch. They are also a slighter race, they weigh less, are less strong muscularly, and have a smaller breathing capacity.

The English, again, are about ·7 inch. shorter than the Scotch, weigh about 4 lb. less, and are less strong.

(2) *Colour of Eyes.*—The greatest percentage of dark eyes is to be found in those undergraduates whose origin is in the west and south-west (34·76 per cent.). The smallest among those who come from the east and south-east (18·75 and 15·38 respectively).

The cephalic indices of the various groups do not show much difference. The chief point of interest is the fact that the dark-eyed English have broader and loftier heads than is the case elsewhere in England. This is just the reverse of what Dr. Beddoe found: "L'association," he says (p. 662), "de la couleur brune ou foncée des cheveux avec la dolichocéphalie paraît être à peu près générale."

I may perhaps incidentally touch on a curious point, which is possibly due to nothing more than the instrument used, and that is, that one can, on the average, see further with the right eye than with the left. The average difference is fairly constant, and amounts to about two centimetres. Whether it is due to anything beyond external causes, I hardly like to say.

	Cephalic index.		Altitudinal index.		Height.		Weight.		Colour of eyes.			
	No. of cases.	Index.	No. of cases.	Index.	No. of cases.	Height in inches	No. of cases.	Weight in pounds.	No. of cases.	Per cent. dark.	Per cent. medium.	Per cent. light.
North England ...	889	79·26	329	71·59	898	69·04	364	153·85	334	30·24	68·86	0·9
Midlands	309	79·1	113	71·63	315	68·84	319	153·4	120	30·83	68·33	0·83
West and South-West	207	79·17	99	72·2	207	68·97	207	154·7	98	34·7	64·28	1·02
East England ...	213	79·43	79	71·97	214	68·51	211	152·9	80	18·75	80·0	1·25
South-East England	59	79·4	28	72·22	60	68·64	58	153·5	26	15·38	84·62	0·0
South England ...	1125	78·96	398	71·91	1131	68·99	468	151·6	403	31·27	67·49	1·24
Total, England ...	3019	79·104	1046	71·819	3042	68·887	1627	153·1	1061	29·88	69·09	1·04
Scotland	211	71·972	76	71·09	212	69·53	213	157·1	75	30·66	69·33	0·0
Ireland	189	78·993	88	71·58	188	69·18	188	157·8	81	20·99	79·01	0·0
Wales	128	79·44	55	70·93	128	68·05	128	149·23	55	30·91	63·64	5·45
Total, British Isles..	3838	79·08	1265	71·72	3871	68·934	2159	153·67	1273	29·33	69·43	1·1
Dark-eyed English	93	79·93	80	72·46	93	68·7	85	152·9	93	100	0·0	0·0

	Span of arms, *i.e.* greatest distance between finger-tips.		Sight, *i.e.* greatest distance seen in centimetres.					Strength measured as pull by archer.		Strength measured by squeezing power of hand in pounds.					Breathing capacity, in cubic inches.	
	No. of cases.	Span in inches.	No. of cases.	Right eye.	No. of cases.	Left eye.	Mean of both eyes.	No. of cases.	Strength in pounds.	No. of cases.	Right hand.	No. of cases.	Left hand.	Mean.	No. of cases.	Cubic inches expired.
North England ...	351	71·55	355	61·9	328	60·4	61·65	356	83·7	329	86·5	353	80·6	83·55	356	259·6
Midlands	131	71·06	130	57·7	128	55·7	56·7	131	83	122	84	125	77·8	80·9	127	255
West and South-West	104	71·4	101	64·0	101	60·2	62·1	104	83·5	98	88·1	97	83·4	85·75	101	262·85
East England ...	90	71·41	85	54·6	87	51·5	53·05	87	79	84	82·8	86	76·6	79·7	89	250
South-East England	32	70·8	27	63	31	59·4	61·2	29	77·6	29	83·6	30	80·2	81·9	32	262
South England ...	467	71·03	445	60·4	451	58·4	59·4	459	81·3	455	84	451	78	81	461	258
Total, England ...	1175	71·25	1143	60·5	1116	58·3	59·4	1166	82·46	1117	85	1162	79·2	82·1	1164	258·1
Scotland	80	71·48	80	59·8	78	56·5	58·2	79	84·5	81	84·6	82	81·6	83·1	81	265
Ireland	90	71·48	85	61·6	86	61·1	61·35	88	83·1	85	85·3	84	81·8	83·6	91	259
Wales	60	69·98	60	62	59	58·5	60·25	59	82·5	60	82·9	58	77	80	60	249·2
Total, British Isles..	1405	71·22	1368	60·6	1339	58·38	59·49	1392	82·62	1343	84·9	1386	79·41	82·16	1396	258·2
Dark-eyed English	93	71	89	65·1	89	62	63·5	93	84·1	90	85·8	90	81·7	83·75	89	264

The table in the adjoining column shows, in each case, the number of instances examined, and the averages calculated from them.

R. J. HORTON-SMITH.

THE SMITHSONIAN INSTITUTION.[1]

I.

Promote, as an object of primary importance, *institutions for the increase and diffusion of knowledge*: in proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened.—GEORGE WASHINGTON, 1796.

I bequeath the whole of my property to the United States of America to found at Washington *an establishment for the increase and diffusion of knowledge among men*.—JAMES SMITHSON, 1826.

Let the trust of James Smithson to the United States of America be faithfully executed by their representatives in Congress: let this result accomplish his object—*the increase and diffusion of knowledge among men*. —JOHN QUINCY ADAMS, 1846.

THE name of the Smithsonian Institution is a household word in America, while in every centre of intellectual activity abroad, it is regarded as the chief exponent of the scientific thought of the people of the United States, thus representing that which is deemed in other lands to be a chief glory of our nation; for, whatever may be thought of American art and literature, or of American instituttons in general, the science of America is everywhere accepted as sound, vigorous, and progressive.

Its activities embrace every branch of human knowledge, for it was the intention of its organisers that art as well as science —the beautiful as well as the true—should receive its fostering care.

The Smithsonian Institution, although it bears the name of a foreigner, has for half a century been one of the most important agencies in the intellectual life of our people. It has been a rallying-point for the workers in every department of scientific and educational work, and the chief agency for the free exchange of books, apparatus of research and of scientific intelligence between this and other countries. Its publications, which include more than two hundred volumes, are to be found in all the important libraries in the world, and some of them, it is safe to say, on the work-table of every scientific investigator. Its great library constitutes an integral and very important part of the national collection at the Capitol, and its museum is the richest in existence in many branches of the natural history and ethnology of the New World. Many wise and enlightened scholars have given their best years to its service, and some of the most eminent men of science to whom our country has given birth, have passed their entire lifetime in working for its success.

The most important service, however, which the Smithsonian Institution has rendered to the nation—intangible, but none the less appreciable—has been its fifty years of constant co-operation with the Government, with public institutions, and with individuals in every enterprise, scientific or educational, which needed its advice, support, or aid from its manifold resources.

Visitors to the city of Washington carry away pleasant memories of the quiet group of buildings among the trees in the Mall, filled with the wonders of nature and art, and the trophies of scientific discovery. Few of them, however, have had the opportunity to visit the administrative offices and laboratories, or to gain any idea of the real significance and value of the work which is being carried on within those walls.

It is probable that no class of the American people appreciates the work of the Institution more fully than the members of Congress. This has been clearly shown by the uniform liberality with which, throughout many successive terms, regardless of changes in the political complexion of the administration, they have supported its policy; by the care with which they disseminate its reports; by the judgment with which they select their representatives upon its Board of Regents, and, above all, by the scrupulous care with which they protect the Institution in its independence of political entanglements. That the Institution has accomplished so much in the past is largely due to the support which it has received from these practical men of

1 By Dr. G. Brown Goode. This paper was printed for distribution at the Atlanta Exposition, and has since been revised and extended for NATURE. It is based upon the author's essay on "The Smithsonian Institution," printed in 1885, in "The Chautauquan" (vol. v. pp. 275-79), and upon later writings, especially "The Origin of the National Scientific and Educational Institutions of the United States" (Report American Historical Association, 1889, pp. 53-100); "The Genesis of the National Museum" (Smithsonian Report, 1891, ii. pp. 273-380), and the article "Smithsonian Institution" in Johnson's Cyclopædia, new edition (vol. vii. 1895).

business, and through them from the people of the United States; since the comparatively small income of the Institution has been made a nucleus for very considerable annual appropriations granted by the United States Congress, for the support of the manifold interests the administration of which have been entrusted to it. It is to such support that it will owe its efficiency in the future, and it seems right that every opportunity should be taken to explain its operations to the public. No intelligent American can fail to appreciate the benefits which the highest interests of the American people receive through the proper administration of the Smithsonian bequest.

THE ORIGIN OF THE INSTITUTION.

The story of the foundation of the Smithsonian Institution sounds more like romance than fact. It seems like the fulfilment of some prophecy, and all the more so because of the promise of the future.

The father of the founder of the Smithsonian Institution, in early life known as Sir Hugh Smithson, was one of the most distinguished members of the English peerage. Upon the plate of his coffin in Westminster Abbey, where he was buried "in great pomp" in 1786, he was described as "the most high, puissant and most noble prince Hugh Percy, Duke and Earl of Northumberland, Earl Percy, Baron Warkworth and Lovaine, Lord Lieutenant and Custos Rotulorum of the Counties of Middlesex and Northumberland and of all America, one of the Lords of his Majesty's most Honourable and Privy Council, and Knight of the most noble Order of the Garter, &c., &c., &c."

While his aged father was supporting this overwhelming burden of honours and dignities, and while his half-brother, Earl Percy, was serving as a Lieutenant-General in the war against the rebellious British colonies in North America,[1] James Smithson, a youth of modest fortune, was acquiring the rudiments of a scientific education in English schools and colleges. He received the degree of Master of Arts from Pembroke College, Oxford, in 1786, the year of his father's death. He was then known as James Lewis Macie, for he did not assume the name of Smithson until several years later, after he had attained to some reputation as a man of science. His mother was not the Duchess of Northumberland, but her cousin, Elizabeth Keate Macie, of Weston, near Bath (widow of James Macie), great-granddaughter of Sir George Hungerford of Studley, and his wife, Lady Frances Seymour, sister of the sixth Duke of Somerset and aunt of Algernon Seymour, Lord Percy, whose daughter Sir Hugh Smithson married, and was thus enabled to assume the name of Percy and the title of Duke of Northumberland.[1]

[1] Lord Algernon Percy, afterwards Duke of Northumberland, commanded the reinforcements at the battle of Lexington in 1775, and led the column which reduced Fort Washington, near New York, in 1776.

The Smithsons were an old Yorkshire family; Sir Hugh, the great-grandfather of James Smithson, having been created baronet by Charles II. in 1660.

James Smithson was undoubtedly proud of his illustrious ancestry, for in his will he described himself as "son of Hugh, first Duke of Northumberland and Elizabeth, heiress of the Hungerfords of Studley, and niece of Charles, the Proud Duke of Somerset."

He was, however, a man of broad, philosophic mind, and his training in the best scientific methods of his day, and association with leading investigators in Germany and France, and with his brother Fellows of the Royal Society of London, had developed in his mind a generous appreciation of the value of scholarship and scientific culture, and of the still greater importance which these were to have in coming years.

"The best blood of England flows in my veins," he once wrote; "on my father's side I am a Northumberland, on my mother's I am related to kings,[2] but this avails me not. *My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten.*"

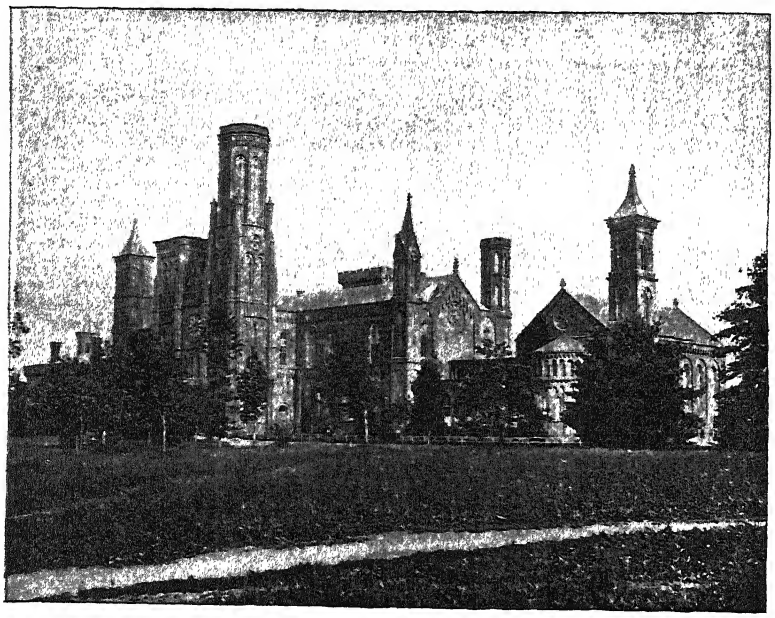


FIG. 1.—The Smithsonian Building.

These words seem little less than prophetic. The founder of the Smithsonian Institution has already earned perpetual fame.

The names of the successive Dukes of Northumberland, his kinsmen, have, as a rule, been little known outside Great Britain, though several of them have been munificent patrons of science.

Smithson seems, early in life, to have come fully into harmony with the scientific spirit of his time. In 1784, while still an undergraduate at Oxford, he made a scientific exploration of the coasts of Scotland in company with a party of geologists. In 1787 he was admitted a Fellow of the Royal Society, and during the remaining forty-two years of his life, in Berlin, Paris, Rome, Florence, and Geneva, he was an associate of the leading men of science, and devoted himself to research. He made an extensive collection of minerals, which was destroyed by the burning of a portion of the Smithsonian building in 1865, and he always carried with him in his travels a portable laboratory for chemical research.

His contributions to science are included in twenty-seven memoirs, chiefly upon topics in mineralogy and organic chemistry, though some of them relate to applied science and the industrial arts. His work, though not of an epoch-making character, was remarkable for its minute accuracy.

Smithson was a greater man than is indicated by his published writings alone. Berzelius declared that he was one of the most accomplished mineralogists in all Europe.

He was a man of generous culture who understood thoroughly the needs of the world in the direction of scientific endowment,

[1] Smithson was born in France in 1765. The date 1754 usually given for his birth and engraved upon his tomb is wrong, as is shown by his Oxford matriculation records. The source of his fortune is not certainly known. At Oxford, where he was entered as a Gentleman Commoner, he was understood to have succeeded to the estate of his mother's husband, Macie, and in 1794 he received a bequest of £3000 from his half-sister, Dorothy Percy. The major portion of his estate, however, came to him by the bequest of his half-brother, Colonel Henry Louis Dickinson, of the 84th Regiment of Foot, who died in Paris in 1820. The statement of Smithson that his mother was "heiress of the Hungerfords of Studley," probably indicates the source of a considerable portion of the wealth of which that document made disposition.

[2] Smithson was of royal descent, through his maternal ancestor, the ill-fated Lady Catharine Grey, great-granddaughter of King Henry VII., grandniece of Henry VIII., and cousin of Elizabeth. His ancestor in the ninth generation, Edward Seymour, the first Duke of Somerset and Protector of England, was the brother of Queen Jane Seymour and the uncle of King Edward VI.

and his action in bequeathing his estate to the people of America was deliberate and well considered.

In that admirable little monograph entitled "Smithson and his Bequest," Mr. W. J. Rhees has pointed out that the tendency of the time of Smithson was towards the establishment of permanent scientific institutions. Between 1782 and 1826, over twenty of the most important academies and societies now in existence were organised. "This period," he writes, "was not less marked by the gloom occasioned by long, protracted and almost universal war, and the extent and rapidity of its social changes, than by the lustre of its brilliant discoveries in science, and its useful inventions in the arts. Pure science had many illustrious votaries, and the practical application of its truths gave to the world many of the great inventions by means of which civilisation has made such immense and rapid progress." In support of these statements he quotes the words of Lord Brougham, who said that "to instruct the people in the rudiments of philosophy would of itself be an object sufficiently brilliant to allure the noblest ambition."

It was with a mind full of such thoughts as these, with perhaps the support and inspiration of Lord Brougham's words quoted above from his "Treatise on Popular Education," printed in 1825, with such models in mind as the Royal Society, whose object is "the improvement of natural knowledge," the Royal Institution "for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching the application of science to the common purposes of life," and the Society for the Diffusion of Useful Knowledge, established in London in 1825, that in 1826 Smithson drew up his will, containing this most significant provision:—

"I BEQUEATH THE WHOLE OF MY PROPERTY TO THE UNITED STATES OF AMERICA TO FOUND AT WASHINGTON, UNDER THE NAME OF THE SMITHSONIAN INSTITUTION, AN ESTABLISHMENT FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE AMONG MEN."

There is no reason known why he should have selected the United States as the seat of his foundation, though it is certain

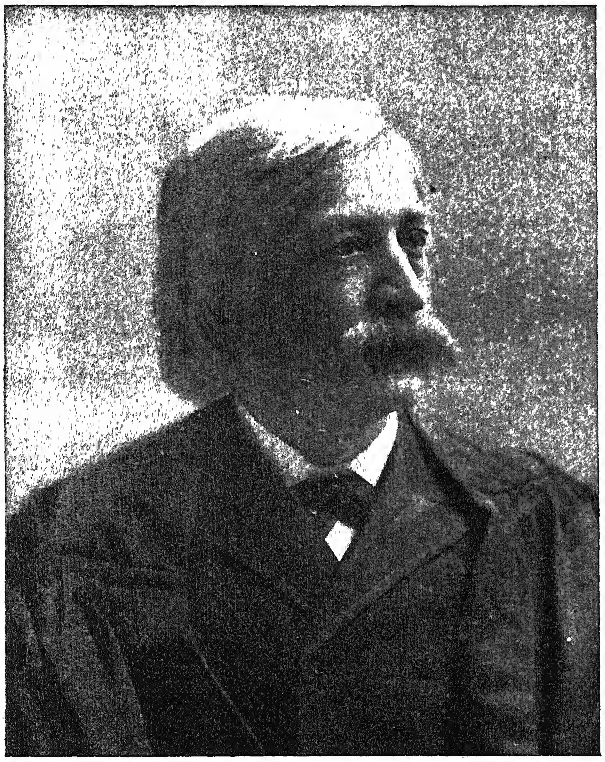


FIG. 2.—Chief Justice Fuller, Chancellor of the Smithsonian Institution.

FIG. 3.—Joseph Henry, First Secretary of the Smithsonian Institution, 1846-78.

Brougham forcibly recommended this idea to the wealthy men of England, pointing out that by the promotion of such ends, a man, however averse to the turmoil of public affairs, might enjoy the noblest gratification of which the most aspiring nature is susceptible, and influence by his single exertions the fortunes of a whole generation.

Very closely do these thoughts correspond to those expressed by Smithson in various passages in his note-books, and especially with that which is used for a motto upon the publications of the Institution:—

"*Every man is a valuable member of society, who by his observations, researches, and experiments, procures knowledge for men.*"

Another sentence of his is still more pregnant with meaning. It is this:—

"*It is in his knowledge that man has found his greatness and his happiness, the high superiority which he holds over the other animals who inherit the earth with him, and consequently, no ignorance is probably without loss to him, no error without evil.*"

that he was in full sympathy with republican governments and the liberty of the people. His library contained only two books relating to America. Rhees quotes from one of these, "Travels Through North America," by Isaac Weld, secretary of the Royal Society, a paragraph concerning Washington, then a small town of 5000 inhabitants, in which it is predicted that "the Federal city, as soon as navigation is perfected, will increase most rapidly, and that at a future day, if the affairs of the United States go on as prosperously as they have done, it will become the grand emporium of the West, and rival in magnitude and splendour the cities of the whole world."

It is probable that he knew Joel Barlow in Paris, and was familiar with his plan for a realisation of Washington's project for a great national institution of learning in the Federal city.

Inspired by a belief in the future greatness of the new nation, realising that while the needs of England were well met by existing organisations such as would not be likely to spring up for many years in a new, poor, and growing country, Smithson founded in the new England an institution of learning, the civilising power of which has been of incalculable value. Who

can attempt to say what the condition of the United States would have been to-day without his bequest? Well did John Quincy Adams say:—

"*Of all the foundations of establishments for pious or charitable uses which ever signalised the spirit of the age or the comprehensive beneficence of the founder, none can be named more deserving the approbation of mankind.*"

In 1835, six years after Smithson's death, the United States legation in London was notified that his estate, amounting in value to about £100,000, was held in possession of the accountant-general of the British Court of Chancery.

As soon as the facts became public, great opposition to the acceptance of the gift arose in Congress. Eminent statesmen, led by Calhoun and Preston, argued that it was beneath the dignity of the United States to receive presents, and that the donor was seeking immortality for too moderate an equivalent. The wise counsels and enthusiastic labours of John Quincy Adams, who seems to have had from the first a thorough appreciation of the importance of the occasion, finally prevailed, and the Honourable Richard Rush was sent to England to prosecute the claim. He entered a friendly suit in the Courts of Chancery in the name of the President of the United States, and obtained, in less than two years, an event unparalleled in the history of Chancery, a favourable decision. The legacy was brought over in the clipper ship *Mediator*, in the form of 104,960 gold sovereigns. These were delivered September 1, 1838, to the Philadelphia Mint, and immediately recoined into American money, yielding 508,318.46 dols. as the first instalment of the legacy. This was soon after increased to 515,169 dols., and in 1867, by a residuary legacy of 26,210.63 dols., the total sum derived from the founder's beneficence, which by careful management had been in 1867 increased to 650,000 dols., a sum which, as has already been shown, derives its significance, not from its own magnitude, but from the manner in which it has been utilised to stimulate the interest of the Government, and to draw to itself larger amounts through special appropriations from Congress. At one time in the early history of the Institution a large portion of its fund was in certain State bonds which became worthless. Congress appropriated money to make good the loss, and the permanent fund, which, swelled by recent bequests, now amounts to 911,000 dols., is held as a deposit at 6 per cent. in the United States Treasury.

For eight years the original legacy lay in the Treasury, while the wise men of the nation tried to decide what to do with it. At the time, the adage that in a multitude of counsellors there is wisdom, did not appear to be applicable; yet the delay, though irksome to those who desired to see immediate results, proved to be the best thing for the interests of the trust. Every imaginable disposition of the legacy was proposed and discussed in Congress; the debates fill nearly three hundred and fifty pages of Rhees' compilation of Smithsonian documents. Hundreds of letters advisory, expostulatory, and dissuasive were received from representative thinkers and from societies at home and abroad. Every man had a scheme peculiar to himself, and opposed all other schemes with a vigour proportionate to their dissimilarity to his own. Schools of every grade, from a national university to an agricultural school, a normal school and a school for the blind, were proposed. A library, a botanical garden, an observatory, a chemical laboratory, a popular publishing house, a lecture lyceum, an art museum, any and all of these and many more were proposed and advocated by this voluntary congress of many men of many minds.

THE THREE SECRETARIES.

The successful organisation of the Institution has been the result of long-continued effort on the part of men of unusual ability, energy, and personal influence. No board of trustees or regents, no succession of officers serving out their terms in rotation could have developed from a chaos of conflicting opinions, a strongly individualised establishment like the Smithsonian Institution. Especially effective in this respect has been the influence of the three men who have in succession held the office of "Secretary." The name of "Secretary," it should be stated, is that which in Washington designates the highest grade of executive responsibility. The Secretary of the Institution makes all appointments on the staff, is responsible for the expenditure and disbursement of all funds, is the legal custodian of all its property, and, *ex officio*, its librarian and the keeper of its museum.

The names of Henry and Baird are so thoroughly identified with the history of the Institution during its first four decades, that their biographies would together form an almost complete history of its operations. A thirty-two years' term of uninterrupted administrative service was rendered by one, thirty-seven years by the other. Perhaps no other organisation has had the benefit of so uninterrupted an administration of forty years, beginning with its birth and continuing in an unbroken line of consistent policy a career of growing usefulness and enterprise.

The first meeting of the Board of Regents took place on September 7, 1846, and before the end of the year the policy of the Regents was practically determined upon, for, after deciding upon the plan of the building now occupied, they elected to the secretaryship Prof. Joseph Henry, and thus approved his plan for the organisation of the Institution which had previously been submitted to them.

Henry was a man greatly distinguished in science through his epoch-making discoveries, which had already given to the world the electro-magnetic telegraph, and which form the foundation of all systems of electric lighting and power.[1] From the age of forty-seven to that of seventy-nine, he merged his life in that of the Institution. Prof. Asa Gray has shown so clearly the deep impression which he made upon the organisation while it was yet plastic, that I quote his words as the best explanation of the character of this element in its history:

Fig. 4.—Spencer Fullerton Baird, Second Secretary of the Smithsonian Institution, 1878-87.

"Some time before his appointment," writes Prof. Gray, "he had been requested by the members of the Board of Regents to examine the will of Smithson, and to suggest a plan of organisation by which the object of the bequest might, in his opinion, best be realised. He did so, and the plan he drew was in their hands when he was chosen Secretary. The plan was based on the conviction 'that the intention of the donor was to advance science by original research and publication; that the establishment was for the benefit of mankind generally, and that all unnecessary expenditure on local objects would be violations of the

[1] Self-induction, and the intensity magnet, with which Henry and Faraday subsequently discovered magneto-electricity

trust.' His 'Programme of Organisation' was submitted to the Board of Regents in the following year, was adopted as its governing policy, and has been reprinted in full or in part in almost every annual report. If the Institution is now known and praised throughout the world of science and letters, it is fulfilling the will of its founder and the reasonable expectations of the nation which accepted and established the trust, the credit is mainly due to the practical wisdom, and the catholic spirit, and the indomitable perseverance of its first Secretary, to whom the establishing act gave much power of shaping ends, which as rough-hewn by Congress were susceptible of various diversion. Henry took his stand on the broad and ample terms of the bequest, 'for the increase and diffusion of knowledge among men,' and he never narrowed his mind, and to *locality* gave what was meant for mankind. He proposed only one restriction, of wisdom and necessity, that in view of the limited means of the Institution, it ought not to undertake anything which could be done,

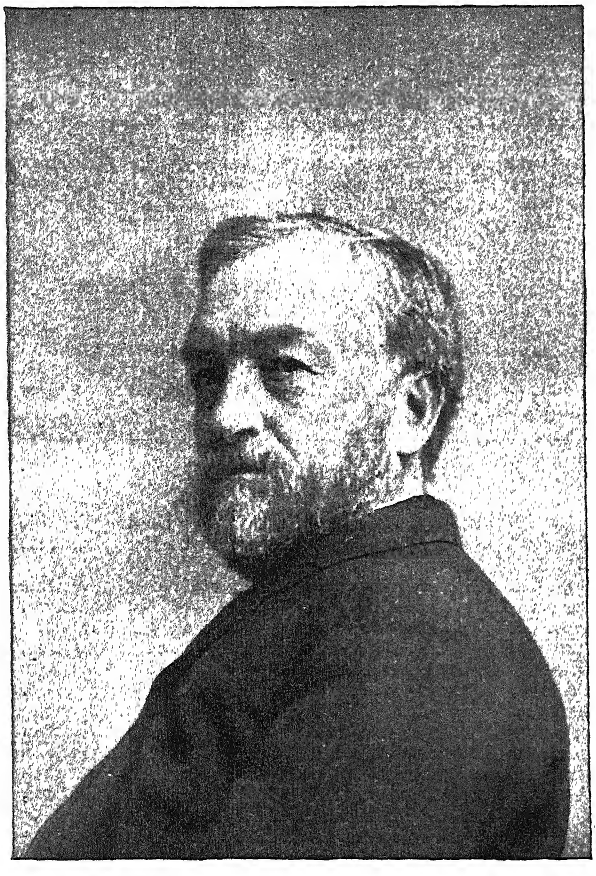


FIG. 5.—Samuel Pierpont Langley, Third Secretary of the Smithsonian Institution.

and well done, by other existing instrumentalities. So as occasion arose he lightened its load and saved its energies by giving over to other agencies some of its cherished work."

His statue, erected by order of Congress, stands in the Smithsonian Park.

Henry was succeeded in the office of Secretary by Prof. Spencer Fullerton Baird, then the leading authority on the mammals, birds, fishes, and reptiles of America, the founder of the U.S. Fish Commission, and of "public fish culture," elected in 1878; and he in his turn, by Samuel Pierpont Langley, pre-eminent as physicist and astronomer, the inventor of the bolometer, the discoverer of a great portion of the infra-red spectrum, and a high authority upon the physics of the atmosphere, elected in 1887.

Each of the three Secretaries, in addition to his general administrative work, has made some feature of the general plan peculiarly his own. Secretary Henry gave especial attention to the publications, the system of international exchanges, and the development of that great system of meteorological observation and weather prediction which has since become the Weather Bureau.

Secretary Baird continued the development of the museum, which had been under his special charge during his twenty-seven years of service as assistant secretary, secured the erection of the new museum building, gave much attention to zoological and ethnological explorations and, in connection with his special work as Commissioner of Fisheries, secured the construction of the exploring ship *Albatross*, and carried on extensive investigations in American waters.

To Secretary Langley is due the establishment of the Nationa Zoological Park and the Astro-physical Observatory, renewed activity in the library and exchange work, and a new system of encouragement of original research in the physical as well as the biological sciences. Under his administration, also, important donations and bequests have been added to the permanent fund of the Institution. The limit of 1,000,000 dols. which may by law be permanently deposited in the United States Treasury at 6 per cent., having nearly been reached, Congress has recognised the authority of the Institution to receive and administer other funds beyond this limit, thus making it possible for it to undertake the administration of financial trusts for any purpose within the scope of its general plan.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A memorial is being circulated for the signature of members of the Senate, asking the Council of the Senate to sanction the formation of a Syndicate to consider on what conditions and with what restrictions, if any, women should be admitted to degrees in the University. It states that "for nearly fifteen years, since February 1881, the University has formally admitted the students of Girton and Newnham to its Honour examinations, and has practically co-operated in their instruction by permitting them to attend the lectures of its teaching staff, and to share the advantages of the University Library and other institutions. At the present time, eight out of the ten universities of Great Britain—viz., the University of London, the Victoria University, the new University of Wales, the four Scottish Universities, and the University of Durham—admit women to degrees. The result is that the women to whom Cambridge now awards only certificates, feel the inferiority of their position in this respect as compared with that of women who pass the examinations of these other Universities. Further, a committee of the Council of the University of Oxford was appointed some months ago to consider the desirability of granting degrees to the women students at Oxford, whose position is now somewhat similar to that of the students of Girton and Newnham. There seems, in short, to be a danger lest Cambridge—which twenty years ago was acting as pioneer in the movement for extending the advantages of academic education to women—should be actually the last to grant them the traditional and customary recognition of their work. The conditions under which degrees should be granted require very careful consideration. It is hoped that the syndicate of which we desire the appointment may be able to frame proposals which will command the assent of all who are interested in the academic education of women."

WE are informed that Mr. N. Busch has not been appointed Director of the Botanic Garden of the University of Dorpat, but assistant to Mr. N. Kuznetzov, formerly Assistant Secretary of the Imperial Russian Geographical Society, who has been also appointed Extraordinary Professor of Botany at the same University, instead of Dr. Russow retired.

DR. G. P. GRIMSBY has been appointed to the chair of Geology and Natural History in Washburn University; Dr. W. B. Rankin and C. F. W. McClure have been appointed to Professorships of Biology in the College of New Jersey; Dr. W. S. Strong has been called to the chair of Geology in Bates College, Lewiston, Maine; and Dr. R. de Girard, privat-docent in Geology at the Zürich Polytechnikum, has been promoted to an Extraordinary Professorship.

At the annual meeting of the Incorporated Association of Headmasters of Secondary Schools, held on January 8, two resolutions were passed with regard to science teaching, which it is to be hoped may bear fruit in the form of an improved method in many of our schools. At the previous annual meeting a discussion had taken place on the subject; and as a result of this a memorial was sent, in July of last year, to the authorities controlling the Local examinations of Oxford and Cambridge Universities, setting forth the desire that "examining bodies should encourage a more rational method of teaching science" by framing the syllabuses on different lines. A committee was also appointed to consider the subject, and this committee, consisting of men possessed of considerable experience in science teaching in secondary schools, has now presented its report. They agree with all scientific educationists in saying that a large proportion of the time given to science in schools should be occupied by the pupils in performing actual measurements themselves, and that the object should be to impart not only information but chiefly the knowledge of method, and with this object in view, that the instruction should be given in strictly logical order. To serve as a basis of discussion with the University authorities, the committee has put forth an admirable syllabus, which includes the more fundamental portions of physics and chemistry, and (an important point) which indicates what experiments can easily be performed by beginners. The syllabus represents a practical scheme of elementary science which will be appreciated by teachers, and which cannot be too widely adopted. It indicates the manner in which the study of science in schools may be made of true educational value, and in the interests of science it is to be hoped that examining bodies will give it full consideration. Examinations at present dominate our educational system, and it is almost hopeless to attempt to introduce into schools a scheme of instruction that does follow the lines laid down by examiners. But if a syllabus is rational, the teaching which follows it will possess good features. If, therefore, the logical syllabus drawn up by the Committee of the Headmasters' Association be adopted by the Delegacy for Local examinations of Oxford and Cambridge, an important step will have been taken in the advance of scientific education in this country.

SCIENTIFIC SERIALS.

American Journal of Science, December 1895.—How to find the key-note of auditoriums, by E. Cutter. If a speaker uses the key-note of his auditorium, the audience shows by attitude and attention that it hears what is said. The speaker speaks with ease, and feels his voice impinge upon the farthest walls. The key-note may be found by means of a siren, or by singing, and observing which note resounds most powerfully. The paper contains practical hints of some value to public speakers, but is unscientific in tone and substance.—Stratigraphy of the Kansas coal-measures, by Erasmus Haworth. The different formations lie one above the other in regular order, similar to the order found in other parts of the world. The general character of the shales throughout the whole of the coal-measures is such that they must have been deposited, in the main, in shallow water, probably ocean-water, as evidenced by the frequency of ripple-marks and other physical properties. The coastal area must have progressed westward as geological time advanced. The thickness of the Kansas coal-measures cannot be much less than 2500 feet.—Igneous rocks of Yogo Peak, Montana, by W. H. Weed and L. V. Pirsson. Yogo Peak is composed of a core or stock of massive, granular, igneous rock, composed chiefly of augite and orthoclase. The mass shows a progressive differentiation along its east and west axis, with a continual increase in the ferromagnesian elements over the felspathic ones.—A new alkali mineral, by Warren M. Foote. This mineral, named Northupite, after its discoverer, crystallises in regular octahedra, whose diameters rarely reach 1 centimetre. It is brittle, shows uneven fracture, and a hardness of 3·5 to 4. In powdering the mineral a fœtid odour is distinctly perceptible. It is easily fusible before the blowpipe, and its analysis indicates it to be a double chloride and carbonate of sodium and magnesium, with traces of phosphoric acid, silica, iron, calcium, and organic matter. It was found in the neighbourhood of the Borax Lake, California.—On the affinities and classification of the Dinosaurian reptiles, by O. C. Marsh. Twelve restorations of Dinosaurs are given, and a relation is traced between them and the Crocodilians.

Wiedemann's Annalen der Physik und Chemie, No. 12.—On the origin of frictional electricity, by C. Christiansen. Differences of potential created by contact between two metals were investigated by means of "drop electrodes," one terminal of the electrometer being connected with the upper reservoir of mercury, and the other with the lower, in which plates of a different metal were immersed. The gas through which the drops fall is of considerable influence. Platinum becomes more positive in hydrogen, and more negative in oxygen. Other metals become more negative in hydrogen.—Dielectric constants of mixtures and solutions, by Ludwig Silberstein. Given two perfect insulators, like benzol and phenylethylacetate, which mix in all proportions and do not contract in the process, the specific inductive capacity of the mixture may be found by taking the sum of the products of the two separate volumes into their specific inductive capacities and dividing by the total volume. This proposition was experimentally proved by Nernst's method, with induction coil and telephone.—On the passage of electricity through gases, by A. Paalzon and F. Neesen. This is the continuation of a highly-interesting paper on various obscure phenomena connected with discharge tubes. The medium in which the discharge tubes were immersed had a decided influence upon them. Immersion in water or alcohol extinguished the glow. This was not due to condensation, since the total current was diminished, and extinction took some time to set in. Electrification of the outer surface of the tube, or discharge of it by a flame or other means, or the approach of a charged piece of sealing-wax—in short, any motion of electricity in the neighbourhood, favoured the internal discharge. —Movable light phenomena in rarefied gases, caused by electric oscillations, by J. Ebster and H. Geitel. In a discharge tube surrounded by a conducting ring put to earth, and touching another conductor connected with a strong induction coil, a pencil of bluish light is formed at a vacuum of 0·01 to 0·001 mm. of mercury, ending in an intense green phosphorescent patch next the conductor, tapering as it passes through the ring, and ending somewhere in the gas space. The approach of a conductor or a magnet makes the pencil assume various shapes and positions.

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 21, 1895.—"On the Variable Stars of the δ Cephei Class." By J. Norman Lockyer, C.B., F.R.S.

Prof. E. C. Pickering, in his classification of the variable stars, which is based on a study of the light curves (*Amer. Acad. Proc.*, vol. xvi. p. 17), recognises two classes of variables having short periods. His Class IV. includes those variables, exemplified by δ Cephei and β Lyræ, in which the light changes are not of very great range, and continue throughout the period. Class V. comprises those like Algol in which there is a temporary reduction of light at minimum, produced by the eclipse of the bright star by a relatively dark companion; this explanation has since been established by spectroscopic investigations, which have shown that there is no change in the spectrum at minimum, and that there is an orbital movement of corresponding period.

Excluding β Lyræ, which, as shown in the paper, is spectroscopically different from the others so far examined, it will be convenient to refer to the remaining variables of Pickering's Class IV. as those of the δ Cephei class, and it is with some of these that the present paper is concerned.

The available spectroscopic data with regard to the δ Cephei class were very meagre, and I therefore determined to investigate the spectra photographically, so far as the means at my disposal would permit. Five stars were studied, namely, η Aquilæ, ζ Geminorum, δ Cephei, T Vulpeculæ, and S Sagittæ.

Five very definite results have been arrived at:—

(1) The spectra of the five variables of this class which have been photographed are practically identical.

(2) The five variables in question are stars of increasing temperature.

(3) There is a general weakening of the continuous spectrum as the light of the star decreases.

(4) There are no indications of bright-line radiation at the positions occupied by the lines of hydrogen or helium at any part of the period in the case of these variables.

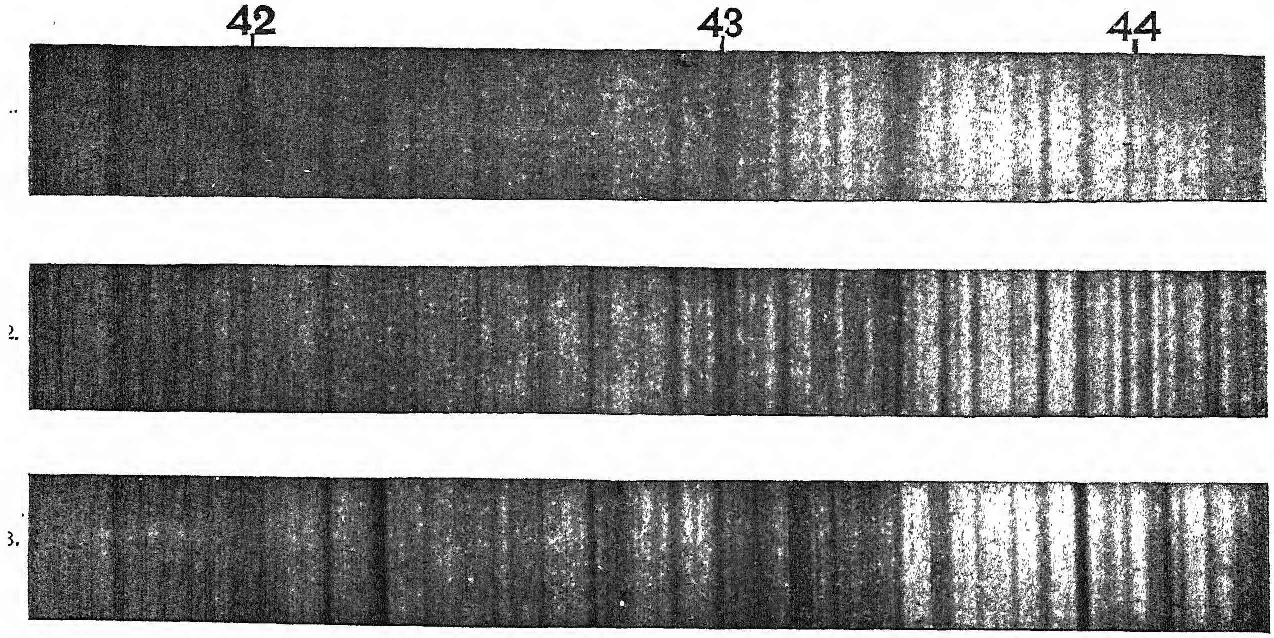
(5) There is no visible doubling of the lines in any of the photographs.

A portion of the spectrum of δ Cephei, at the time of maximum, is compared with the spectra of γ Cygni and Arcturus in the accompanying diagram. These have been enlarged about ten times from the original negatives taken at Kensington.

Taking Arcturus as a representative star of the solar type (*Phil. Trans.*, 1893, vol. 184, A, p. 699), it will be seen that although the spectra of γ Cygni and δ Cephei resemble it in showing a large number of dark lines, they differ considerably from it in point of detail.

Since the greater part of the foregoing was written, the results of a photographic study of the spectrum of δ Cephei, with special reference to its movement in the line of sight, have been published by Belopolsky (Imp. Acad. Sc., *St. Petersburg Bull.*, November 1894). Belopolsky differs from me in classing the star as a solar one, although he draws attention to numerous differences between the spectrum of the star and that of the sun.

He also finds, as I have found, that there is probably no change of spectrum corresponding to the light changes, except a general change of intensity.



1. δ CEPHEI 2. γ CYGNI 3. ARCTURUS

Linnean Society, December 19, 1895.—Mr. W. P. Sladen, Vice-President, in the chair.—Mr. William Scott was elected, and the Rev. T. R. Stebbing, Rev. H. P. Fitzgerald, and Mr. A. W. Geffcken were admitted Fellows of the Society.—Mr. W. B. Hemsley exhibited specimens and photographs of *Cacteæ* from the Galapagos Islands, and gave an account of some of the more remarkable species.—Mr. George Brebner exhibited and described, with the aid of microscope and lantern slides, several new and rare Algæ.—Mr. J. E. Harting exhibited a living specimen of the Snow Bunting (*Emberizu nivalis*), which had been captured, with several others, off Cape Race on board the s.s. *Ottoman* in October last, during the voyage from Boston to Liverpool, as mentioned at a former meeting (November 7).—Mr. R. A. Rolfe gave an abstract of a paper entitled "A Revision of the Genus *Vanilla*," in which some fifty species were enumerated, seventeen of which were new, though five of them had been previously confused with older forms. The plants in this genus were described as tall forest climbers, some of them leafless, found almost throughout the tropics, though generally somewhat local in their distribution. Of the species described, 29 were American, 11 Asiatic, and 10 African.—Mr. E. S. Goodrich communicated a report on the collection of Cephalopoda in the Calcutta Museum. He explained that this collection had been forwarded from Calcutta to Prof. Ray Lankester, at whose request he had undertaken to examine and report upon the species. It contained 162 specimens, almost all of which were collected in the Indian Seas, from the Persian Gulf to the coast of Australia, during the cruise of H.M.S. *Investigator*. Fifteen genera were represented, and several new species were described belonging to the genera *Chairotenthis*, *Histiopsis*, *Abralia*, *Loliolus* and *Faonius*. The paper was illustrated by original drawings.

PARIS.

Academy of Sciences, January 6.—M. A. Cornu in the chair.—M Chatin was elected Vice-President for 1896.—The retiring President (M. Marey) announced to the Academy how the vacancies arising in 1895 amongst the members and corresponding members had been filled up.—Note on the works of Mr. John Russell Hind, late correspondent of the Astronomical Section, by M. F. Tisserand.—An aneurism of the neck, face, and mouth treated by the sclerogenous method, by M. Lannelongue. An account of the successful treatment of a widespread aneurism by injections of zinc chloride solution (10 per cent.).—On the Calendar, by M. Flamant. A criticism of an alteration of the Gregorian rule for finding leap-year, suggested by M. Auric. The alternative proposed by the author, not to consider as leap-years the dates $(32)^n \times 100$, that is, 3200, 6400, &c., has the advantage of postponing any departure from the Gregorian rule for 1200 years. The length of the mean solar year deduced from this is only two-millionths of a mean solar day in excess of the truth.—On integral invariants, by M. G. Kœnigs.—On a method of splitting up some definite integrals into simple elements, by M. M. Petrovitch.—On the absolute values of the magnetic elements on January 1, 1896, by M. T. Moureaux. The absolute values and secular variation during 1895 of declination, inclination, horizonal and vertical intensity, and total force are given for the two observatories of Parc Saint-Maur and Perpignan.—The action of nitrogen peroxide on the halogen salts of tin, by M. V. Thomas. The reaction was studied in chloroform solution. Tin tetrachloride gave a crystalline substance of the empirical composition $Sn_4Cl_{14}.N_2.O_6$. This is hygroscopic, and is decomposed on heating. Tin tetrabromide gave $Sn_4.Br_6.N_2O_{10}$ as a white powder. The product obtained from the tetraiodide contained no iodine, and had the composition $Sn_5O_{11}(NO_3)_2 + 5H_2O$.—On a mode of decomposition of some amides and amido-compounds, by M. Œchsner de Coninck. An account of the results obtained on treating some aromatic amides and amido-

derivatives with an alkaline solution of sodium hypochlorite.—The *rôle* of the fever in the evolution of an infectious disease, by M. Cheinisse.—On serotherapy of tuberculosis, by MM. V. Babes and G. Proca. In the case of the animals used, chiefly dogs, immunity to virulent tuberculous injections was effected by treatment with tuberculin in increasing doses for several months, followed by subcutaneous injection in increasing doses of the dead bacilli that had already served for the preparation of the tuberculin.—On the embryonic membranes of the *Molgulæ*, by M. A. Pizon.—On the gills of the *Tetraclita porosa*, by M. A. Gruvel. The oxygenising surface of the gills is enlarged in a peculiar manner; instead of only one lamella, there are from eight to ten, of different sizes, according as they are at the ends or the middle of the gill, each of which is folded on itself in the most irregular fashion.—Note on *Mucor* and *Trichoderma*, by M. J. Ray. A description of a new species of mucor, to which the name of *Mucor crustaceus* is given, and of a parasite much resembling *Trichoderma viride*. This case of parasitism is accompanied by important modifications, both of the host and of the parasite: in the former, the mineral coating being largely increased, and its spores reduced in number; in the latter, appearance of a continuous structure, and reduction of the fructiferous apparatus.—On the yield of flour from wheat, and on whole-meal bread, by M. Balland.—On some French lakes, by M. A. Delebecque.—On the abyss of Gaping Ghyll, by M. E. A. Martel.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 16.

ROYAL SOCIETY, at 4.30.—The Rotation of an Elastic Spheroid: S. S. Hough.—On a Type of Spherical Harmonics of Unrestricted Degree, Order, and Argument: Dr. Hobson, F.R.S.—Memoir on the Theory of the Partitions of Numbers. Part I.: Major MacMahon, F.R.S.—Some Physical Properties of Argon and Helium: Lord Rayleigh, Sec.R.S.
LONDON INSTITUTION, at 6.—Experiments with Incandescent Lamps: Prof. Fleming, F.R.S.
LINNEAN SOCIETY, at 8.—On the Fistulose Polymorphinæ and the Ramulinæ: Prof. T. Rupert Jones, F.R.S., and F. Chapman.
SOCIETY OF ARTS, at 4.30.—The Shan Hills: their Peoples and Products: Colonel R. G. Woodthorpe, C.B., R.E.
SOCIETY OF ANTIQUARIES, at 8.30.
CHEMICAL SOCIETY, at 8.—The Acetylene Theory of the Luminosity of Hydrocarbon Flames: Prof. Vivian B. Lewes.—And other Papers.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums.—Inaugural Address of the President, Dr. John Hopkinson, F.R.S.
NUMISMATIC SOCIETY, at 7.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—More about Argon: Lord Rayleigh, Sec.R.S.
QUEKETT MICROSCOPICAL CLUB, at 8.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Iron Tunnels: W. O. Leitch.
EPIDEMIOLOGICAL SOCIETY, at 8.—Experiences in Relation to Cholera in India from 1842-79: Surgeon-General C. A. Gordon, C.B.

SATURDAY, JANUARY 18.

ROYAL INSTITUTION, at 3.—To the North of Lake Rudolf and among the Gallas: Dr. A. Donaldson Smith.

MONDAY, JANUARY 20.

SOCIETY OF ARTS, at 8.—Alternate Current Transformers: Dr. J. A. Fleming, F.R.S.
VICTORIA INSTITUTE, at 4.30.—On Newly-deciphered Inscriptions: Mr. Pinches.
LONDON INSTITUTION, at 5.—Cambridge University; its History and Development: E. J. C. Morton, M.P.

TUESDAY, JANUARY 21.

ROYAL INSTITUTION, at 3.—The External Covering of Plants and Animals: Prof. C. Stewart.
ROYAL PHOTOGRAPHIC SOCIETY, at 8.—On Irregular Grained Screens: E. Sanger Shepherd.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water-Supply: Hon. R. C. Parsons.
ANTHROPOLOGICAL INSTITUTE, at 8.30.—Annual Meeting.
ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, JANUARY 22.

SOCIETY OF ARTS, at 8.—Supply of Sea-Water to London: Frank W. Grierson.
GEOLOGICAL SOCIETY, at 8.—On the Speeton Series in Yorkshire and Lincolnshire: G. W. Lamplugh.—On Cretaceous Podophthalmata from Vancouver and Queen Charlotte Islands: Dr. Henry Woodward, F.R.S.—On a Fossil Octopus from the Cretaceous of the Lebanon: Dr. Henry Woodward, F.R.S.—On Transported Boulder Clay: Rev. Edwin Hill.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.
CHEMICAL SOCIETY, at 8.—Helmholtz Memorial Lecture: Prof. G. F. Fitzgerald, F.R.S.
LONDON INSTITUTION, at 6.—Unexplored Glaciers of Vatna Jökul: F. W. W. Howell.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.
SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—Ludwig and Vitalism: Prof. Burdon Sanderson, F.R.S.
PHYSICAL SOCIETY, at 5.—Exhibition of some Geometrical Instruments: E. Scott and Signor Monticolo.—On Resultant Tones: Prof. J. D. Everett, F.R.S.—Experiments with Incandescent Lamps: Sir D. Salomons.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Object Lessons for Infants: V. T. Murché, Vol. 2 (Macmillan).—Ethnology: A. H. Keane (Cambridge University Press).—Popular Telescopic Astronomy: A. Fowler (Philip).—Journal of Microscopy and Natural Science, third series, Vol. 5 (Baillière).—The Steam Engine: Prof. J. H. Cotterill, 3rd edition (Spon).—Folk og Natur i Finmarken: H. Reusch (Kristiania, Brogger).—A New View of the Origin of Dalton's Atomic Theory: H. E. Roscoe and A. Harden (Macmillan).—Types of American Character: G. Bradford (Macmillan).—Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt, Band ii. (Berlin, Springer).—Beobachtungen der Russischen Polar Station an der Lenamündung, 1 Theil, 1882-84.—Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles, Band xxxiv. (Williams).—The Koh-i-Nûr Diamond: E. W. Streeter (Bell).—Ostwald's Klassiker der Exakten Wissenschaften, Nr. 67 to 71 (Leipzig, Engelmann).—The Life and Letters of George John Romanes (Longmans).—Discoveries and Inventions of the Nineteenth Century: R. Routledge, 11th edition (Routledge).

PAMPHLETS.—Some Factors in the Evolution of Adaptations: G. D. Haviland (Porter).—La Théorie Atomique et la Théorie Dualistique: Prof. E. Lenoble (Paris, Gauthier-Villars).—Government and Religion of the Virginia Indians: Dr. S. R. Hendren (Baltimore).

SERIALS.—Engineering Magazine, January (Tucker).—American Journal of Science, January (New Haven).—Journal of Anatomy and Physiology, January (Griffin).—Verhandlungen der Naturhistorischen Vereins der Preussischen Rheinlande, &c., 52 Jahrg. 1 Hälfte (Bonn).—Psychologische Arbeiten, Erster Band, 2 and 3 Heft (Leipzig, Engelmann).—Strand Magazine, January (Newnes).—Strand Musical Magazine, January (Newnes).—American Naturalist, January (Philadelphia).—Journal of the Chemical Society, January (Gurney).—Himmel und Erde, January (Berlin).—Berichte der Naturforschenden Gesellschaft zu Freiburg i.B., June, September, 1894; September 1895 (Williams).—Morphologisches Jahrbuch, 23 Band, 3 and 4 Heft (Williams).—Zeitschrift für Wissenschafte Zoologie, lx. Band, 4 Heft: Ditto, lxi. Band, 1 Heft (Williams).

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THURSDAY, JANUARY 23, 1896.

SOME RECENT WORKS ON BUTTERFLIES AND MOTHS.

A Handbook of British Lepidoptera. By Edward Meyrick, B.A., F.Z.S., F.L.S., F.E.S., Assistant Master at Marlborough College. (London: Macmillan and Co., 1895.)

British and European Butterflies and Moths (Macro-Lepidoptera). By A. W. Kappel, F.L.S., F.E.S. (Assistant Librarian, Linnean Society), and W. Egmont Kirby, L.S.A. With thirty coloured plates by H. Deuchert and S. Slocombe. (London: Ernest Nister, 1895.)

Die Artbildung und Verwandschaft bei den Schmetterlingen. II. Theil. Eine systematische Darstellung der Abänderungen, Abarten, und Arten der Schwalbenschwanz-ähnlichen Formen der Gattung Papilio. Von Dr. G. H. Theodor Eimer, Professor der Zoologie und vergleichenden Anatomie zu Tübingen. Unter Mitwirkung von Dr. K. Fickert, I. Assistent an der Zoologischen Anstalt daselbst. Mit 4 Tafeln in Farbendruck und 7 Abbildungen im Texte. (Jena: Gustav Fischer, 1895.)

LAST year was remarkable for the unusual number of publications on *Lepidoptera* which were issued from the press, especially in England. In addition to serial works and reprints, many independent works appeared, several of which have already been noticed in the columns of NATURE; and the three new books to which the present article refers, shows that the activity of entomologists in this direction is still as great as ever.

It is singular that, notwithstanding the great increase of interest taken in the British *Lepidoptera* of late years, Mr. Meyrick's is really the first serious attempt at a student's manual of the order which has yet appeared. We have any amount of popular illustrated books; but nothing beyond, except Stainton's "Manual of British Butterflies and Moths," a book nearly forty years old (though still of great value and much used, especially as it gave the only available synopsis of the *Micro-Lepidoptera*, which are generally neglected in popular works), and written rather for beginners than for students. Mr. Meyrick now offers us, in a compact volume of nearly 850 pages, a series of carefully drawn up descriptions of genera and species, with notices of localities, range, transformations, &c., and numerous systematic and phylogenetic tables; but there is not a trace of popular padding, and no illustrations, except occasional woodcuts of neuration.

As is known to all who have examined Mr. Meyrick's previous entomological writings (which have chiefly been devoted to the *Lepidoptera* of Australia and New Zealand), he attaches great importance to the neuration of the wings of the insects; and in the present volume he has adopted a new classification of his own, based mainly on the wing-neuration, which will appear to most of his readers little short of revolutionary. Suffice it to say that he divides the *Lepidoptera* into nine main groups, as follows: (1) *Caradrinina*, including the bulk of the species generally classed under *Arctiidæ*, *Liparidæ*, and part of *Noctuæ*; (2) *Notodontina*, including, in addition to the *Notodontidæ*, the *Saturniadæ*, *Sphingidæ*, *Geometræ*, and part of *Noctuæ*; (3) *Lasiocampina*, including also the *Drepanulidæ* and *Endromididæ*; (4) *Papilionina*, including the butterflies; (5) *Pyralidina* (from which group Mr. Meyrick believes the butterflies have branched), including also the Crambi and Plume moths; (6) *Psychina*, with which are included the *Zeuzeridæ*, *Zygænidæ*, and *Heterogenidæ*; (7) *Tortricina*, with which is included *Trypanus cossus*, L.; (8) *Tineina*, including also *Ægeriadæ*; and (9) *Micropterygina*, including the *Hepialidæ* and *Micropterygidæ*. Comment is needless; every one who knows our British *Lepidoptera* will recognise the sweeping character of the changes proposed; and how far they will ultimately be accepted, no one can venture to predict at present.

We will now turn to the second book on our list, which is a complete contrast to the last in design and execution. It is a handsomely got-up book intended for popular use, and illustrated with a series of excellent coloured plates, representing a considerable number of the more interesting and conspicuous butterflies and larger moths of Great Britain and the adjacent parts of Europe. All, or nearly all, the species not figured, but which fall within the limits of the book, are described in the text. No innovations of arrangement or nomenclature are attempted; and English as well as Latin names are used throughout. The book extends to the *Geometræ* inclusive; but it is more fully illustrated in the earlier groups than in the later. Useful information on technical terms, collecting and preserving, and other general matters connected with *Lepidoptera*, will be found in the introduction. This book may be safely recommended as a desirable addition to school libraries, or public institutions, or as a present to a young friend interested in natural history.

The last book on our list is one of a very different kind to the others. It is an elaborate philosophical study of the various forms presented by three groups of swallow-tailed butterflies, represented by *Papilio Turnus*, *Machaon*, and *Asterias*, in various parts of their range. These are mainly Palæarctic and Nearctic in their range. In the first volume of his work, published in 1889, Dr Eimer discussed the groups represented by *Papilio Podalirius*, *Antiphates*, *Anticrates*, *Ajax*, and *Policenes*, which are chiefly East Indian or African, though *P. Ajax* and its allies are American.

Dr. Eimer has come to the conclusion that natural selection will not account for the origin of species, though it may largely contribute to their preservation when already formed. This he expresses in a rather polemical preface, in which he claims to have practically demolished natural selection in the former sense. Perhaps it will be most fair to him to quote a paragraph, especially as it contains most of the technical terms which he uses in his work.

"In complete contrast to the teachings of Darwin, my butterflies everywhere display the origin of new peculiarities through orderly development in a few definite directions (Orthogenesis) on the basis of physiological causes, by organic increase (Organophysis). They show that it is really Genepistasis, or arrest of development at definite stages, which necessitates the separation into species of the organic chain which has

thus originated, and which is, in fact, the cause of the origin of species, independently of, and apart from other causes, discussed in the following pages, such as impediments to fertilisation (Kyesamechanism), and sudden development (Halmatogenesis)."

It is probable that various causes, acting unequally in different groups of animals and plants, have contributed to the origin and differentiation of species; and there is certainly much to be said in favour of the view that evolution proceeds along definite lines, and also that it is liable to be arrested at certain definite points. With respect to the latter phenomenon, we may refer to Dr. Leuthner's monograph of the *Odontolobidæ*, a family of East Indian stagbeetles, published in the *Transactions* of the Zoological Society for 1886, which illustrates this very clearly. It may also be observed in the common earwig.

Besides the discussion of the various points noted in the above-quoted paragraph, this work contains incidental remarks on the influence of heat and cold on butterflies reared artificially; and on mimicry, &c., as well as a reply to some criticisms by the late Dr. Haase on the first volume of the work.

While the philosophical part of the book will be read with interest by students of evolution, the special part, with its excellent illustrations of closely allied species and varieties, will be useful to collectors of foreign butterflies generally.

RECENT WORKS ON PHYSIOLOGY.

A Manual of Physiology. By G. N. Stewart, M.A., D.Sc., M.D.Edin. (London: Ballière, Tindall, and Cox, 1895.)

Physiology. By A. Macalister, LL.D., M.D., F.R.S. "Manuals of Science Series." (London: Society for Promoting Christian Knowledge, 1895.)

Elementary Physiology. By J. R. Ainsworth Davis, B.A. (London: Blackie and Son, 1895.)

WE have at the present time several very excellent text-books of physiology in English, adapted for the various needs of different classes of students. And to prevent these being inconveniently increased, it is a matter of tacit agreement amongst teachers of physiology that it is undesirable to afford a welcome to any new text-book, unless it has itself the highest claims to recognition. These claims may be based either upon some novel method of treatment of the subject, or upon the impression on the work of an author's high personal authority.

Adopting such a standard of criticism as the above, we first proceed to consider Dr. Stewart's manual. The fact of the author possessing so brilliant a reputation in the application of physics to physiology, is sufficient to make a work at his hands of the utmost value in certain branches of the subject. There are other influences to which Dr. Stewart has been exposed, which also tend to enhance the value of his work. The teaching methods of the Edinburgh school involve both conciseness and dogmatism, and these are as desirable in elementary instruction as they are pernicious in more advanced.

The manual which Dr. Stewart has written is to be regarded as an elementary *text-book*, for it is really something more than a mere *manual*. The methods throughout involve a concise expression of varying views, and the author's personal preference for any particular view is clearly indicated. Such a method we consider very desirable in a book of this character. As regards the facts incorporated, they include in general the very latest work that the time of publication permitted, and indicate an acquaintance with the progress of physiology as is possible only with a specialist in that branch of science. Interwoven with the academic exposition are detailed instructions for practical work. We have not very much faith in the success of this innovation. It is extremely inconvenient for a student to have to carry from his home to his laboratory a somewhat bulky volume, and the instructions are of no value except in the laboratory. We certainly think that it would have been much better to have omitted from such a book as this all practical instruction. We would like to offer some criticism also upon this practical instruction. It is to a considerable extent of such a character as to be impossible even to an American student, though Dr. Stewart dwells on the greater opportunities existing on the other side of the Atlantic for practical investigation. We have some doubts, also, concerning the advisability of introducing the so-called electro-physiology to the extent that has been done. It is not that too many pages have been allotted to it; on the contrary, if introduced at all, it requires many more than the author saw his way to give. The result is that, though so much has been referred to, it has been treated so briefly that the fault of brevity, vagueness, is only too apparent. We think that few students will derive the proper amount of information from this section unless it be largely supplemented by the personal instruction of a teacher.

For certain classes of students, however, the book will be of special service, and we think that it will undoubtedly be regarded as a valuable addition to our present text-books of physiology.

For Prof. Macalister's little manual we have nothing but praise. So much of elementary physiology as it is generally understood is identical with elementary anatomy that the physiologist is not at more advantage than the anatomist in describing the more elementary facts. A somewhat novel arrangement of the different points treated upon has been adopted. The author has commenced by describing the nature of food and digestion. This is already a matter of some slight acquaintance to one who has not studied physiology, and he is thus led on through partially familiar paths.

Sections then follow, treating of the blood, the circulatory system, respiration, the skeleton, joints, the nervous system, and the organs of the senses. A small amount of histology has also been introduced. The author throughout the book teaches valuable hygienic lessons from the explained phenomena. In a later edition a few corrections might be introduced; and when that is done, the book will be an excellent guide to the explanation of elementary physiological principles.

Mr. J. R. Ainsworth Davis's work is intended by the author (1) for elementary students in general; (2) for students of general biology who wish to supplement the subject on the physiological side; (3) students of psychology; (4) students of agriculture and dairying.

The necessities of these different classes of students had carefully to be borne in mind in writing the book, and consequently a work of somewhat peculiar character has been compiled. We think it undesirable that the aim of an author should be quite so far-reaching. The extensiveness is bound to detract from the value of the work for any particular class. As regards the matter actually in the volume, it is more elementary in character than that of Prof. Macalister's little book, though occupying about double the space. A redeeming feature of the work is the illustrations, which are judiciously chosen and very well executed. J. S. EDKINS.

OUR BOOK SHELF.

Practical Plane and Solid Geometry. By Joseph Harrison, M.I.M.E., A.M.I.C.E., and G. A. Baxandall. Pp. vi + 183. (London: Macmillan and Co., 1895.)

PRACTICAL geometry is taught primarily as an aid to systematic, accurate and rapid delineation of concrete objects, and, in most cases, it forms part of the student's work very early in his scientific or technical training.

In the organised science school the subject is taken contemporaneously with the first or first two books of Euclid; while the student in a technical school almost invariably goes through his elementary course of practical geometry before he arrives on the other side of the *pons asinorum.* This seems to be hardly logical, for the more important problems in practical plane geometry to be found in elementary text-books depend on propositions in Euclid's third and sixth books; and the early problems in solid geometry are based on theorems in the eleventh book; but in the majority of technical classes it is in the nature of things that practical geometry must be taught where Euclid's sixth and eleventh books are practically sealed. It is imperative that every student should be satisfied with the foundation upon which his future work is to be built; and the truth of theorems, which have such general application as that of similar triangles, must be made apparent at the outset; and with beginners, this can best be done experimentally. It is rarely that the author of a text-book is bold enough to advocate the experimental demonstration of the truth of a law in geometry, though that is almost the only method in many other branches of science.

In the little work before us, Messrs. Harrison and Baxandall have so far deviated from the beaten track as to get through a good deal of their work without some of the usual cumbrous and, to beginners, unintelligible definitions; and have added, in the form of an appendix, some theorems and definitions that may be found useful in a second reading. Some new problems have been introduced in the first and second chapters, which are devoted to plane geometry and graphic arithmetic respectively. The authors have wisely condensed the whole of the former into one chapter; and though one may be considered pedantic for saying so, there are still left in some problems that can hardly be called by the first word of the title-page. It is with great satisfaction that we notice the absence of any attempt to introduce statics with the graphic arithmetic. Too much can hardly be said in favour of graphic statics in its proper place; but when taught without any reference to the laws of equilibrium, it is not only useless but harmful.

The student is gradually led on to the study of solid geometry by a series of well-chosen diagrams and figures, and becomes well-grounded in the orthogonal projection of solids before he approaches the usual oblique line and plane problems. The figures in the text are bold, clear, plentiful and well-lettered; and this is a feature which, if lost sight of, causes much inconvenience and annoyance.

Altogether this is a work which is very carefully compiled, and from which a student can extract for himself a great deal of information without outside assistance.

A Treatise on Hydraulics. By Prof. Henry T. Bovey. Pp. viii + 336. (New York: John Wiley and Sons. London: Chapman and Hall, 1895.)

THE contents of this book formed the subject-matter of a series of lectures on hydraulics, delivered by the author at McGill University, Montreal; and though chiefly intended for students, it will doubtless prove valuable for reference to hydraulic engineers. The book deals with the experimental theory of the motion of water, its flow in pipes and open channels, and its practical application to hydraulic motors. The subject is divided into seven chapters, treating successively of flow through orifices and over weirs, fluid friction, flow in pipes, flow of water in open channels, methods of gauging, impact, and hydraulic motors and centrifugal pumps. The matter is, for the most part, treated mathematically; and the book will be mainly useful to persons who have studied mathematics; whilst numerous examples are appended at the end of most of the chapters, together with their answers, which will give students facility in working out hydraulic problems, and enable them to acquire a more thorough grasp of the principles enunciated. One hundred and ninety-six simple diagrams and drawings serve to illustrate and elucidate the text; and the book, being clearly and concisely written, will enable the intelligent reader, with some knowledge of mathematics, to obtain a deeper insight into the theory of hydraulics, and the principles of its application to practical purposes. The short chapter on gauging the velocity of flow in open channels, describes briefly and practically the different instruments used for the purpose; whilst the long final chapter, on hydraulic motors, explains, with the aid of formulæ, the principles involved in the hydraulic ram, pressure-engines, the accumulator, hydraulic brakes, the various forms of water-wheels and turbines, and centrifugal pumps.

The Scientific Foundations of Analytical Chemistry. By Wilhelm Ostwald, Ph.D. Translated by George McGowan, Ph.D. (London: Macmillan, 1895.)

THE peculiarly interesting character of this book has already been pointed out in the review of the German edition (see NATURE, vol. li. p. 482), and Dr. McGowan's translation now places its doctrines within the reach of English readers.

The only alteration made by the author upon the original edition, is the introduction of a portion of a chapter on the theory of electrolytic methods of analysis. This includes an account of the mode in which the processes of oxidation and reduction occurring in voltaic cells, and the order in which metals separate from a mixture of electrolytes under the influence of a definite external electromotive force, can be correlated with the potential differences given by the metals and the electrolytes used. J. W. R.

Elementary Algebra. By J. W. Welsford, M.A., and C. H. P. Mayo, M.A. Pp. xiii + 407. (London: Longmans, Green, and Co., 1895.)

SINCE, in its early stages, algebra is a generalisation of arithmetic, the authors give a short account of some of the processes of arithmetic, as an introduction to their subject. The book differs in character and arrangement from most text-books on algebra: for instance, the radical sign is explained at the same time as the positive integral index; factors are freely used; a table of logarithms is introduced; and oral exercises are given. There are about four thousand examples to test the student's knowledge, and impress the book-work upon his memory.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On Röntgen's Rays.

PROF. RÖNTGEN'S remarkable discovery will materially affect our views concerning the relation between the ether and matter; but further experimental evidence is required before any opinion can be expressed as to the character of the rays, which behave in so straightforward a manner that they seem to upset all one's notions of the laws of nature. Prof. Röntgen, on the strength of his carefully-conducted experiments, has arrived at a conclusion adverse to the idea that the rays only differ from light rays by the smallness of wave-length. Perhaps the following considerations may show that the evidence is not conclusive in this respect.

Röntgen's rays are not kathode rays—there can be no doubt on that point—but they are generated at the point of impact between the kathode ray and solid substances.

The discoverer has not been able to obtain any interference effects, possibly, as he says, owing to the weakness of the radiation. An absence of interference would not, however, be sufficient to show that the radiation is not of the nature of ordinary light, but only that it does not possess sufficient regularity, or, in other words, that the disturbance is not sufficiently homogeneous. That this is the case is not at all improbable, for the radiation is produced by an impact, which in the first instance may be an impulsive motion propagated outwards, and after passing through the screen, would only possess such regularity as is impressed on it by the absorption of the longer waves.

The great argument against the supposition of waves of very small length lies in the absence of refraction; but is this conclusive?

When we speak of the size of the atoms, we mean their distance in the solid and liquid state. The properties of the ether may remain unaltered within the greater part of the sphere of action of a molecule. The number of molecules lying within a wave-length of ordinary light is not greater than the number of motes which lie within a sound-wave, but, as far as I know, the velocity of sound is not materially affected by the presence of dust in the air. Hence there seems nothing impossible in the supposition that light-waves, smaller than those we know of, may traverse solids with the same velocity as a vacuum. We know that absorption bands greatly affect the refractive index in neighbouring regions; and as probably the whole question of refraction resolves itself into one of resonance effects, the rate of propagation of waves of very small lengths does not seem to me to be pre-judged by our present knowledge. If Röntgen's rays contain waves of very small length, the vibrations in the molecule which respond to them would seem to be of a different order of magnitude from those so far known. Possibly we have here the vibration of the electron within the molecule, instead of that of the molecule carrying with it that of the electron.

I should like, further, to express a certain sense of satisfaction that Röntgen's rays are not deflected in a magnetic field. They are thus clearly separated from kathode rays. The idea that kathode rays are due to vibrations has become fashionable; yet the fact that the magnet deflects them just as it would an electrified molecule, has always seemed to me to be conclusive against this view. No one has, so far, given any plausible reason why a ray of *invisible* light should be able to run round in a spiral, while a ray of *visible* light goes straight; and, so far, Röntgen's rays behave as we should expect well-conducted vibrations to do.

It is not my intention to argue in favour of any particular theory, or against Röntgen's suggestion that we have at last found the formerly missed longitudinal wave. I only desire to put those points forward which at first sight seem to go against the supposition of ordinary light vibrations, and to raise the question whether they constitute an insuperable difficulty.

ARTHUR SCHUSTER.

IN connection with the wonderful discovery by Prof. Röntgen of photographic rays, apparently hitherto unknown, and in connection with the speculation which concludes Prof. Röntgen's most interesting paper, that these rays may perhaps be longitudinal vibrations of the luminiferous ether, the following extracts will probably be found of interest to the readers of NATURE. They are taken, by permission of Lord Kelvin, from his Baltimore Lectures, delivered at the Johns Hopkins University in 1884.

The first extract is from the reprint (now in progress) of Lecture IV. Referring to mathematical work immediately preceding, Lord Kelvin says:—". . . We can do that [obtain certain forms of solutions of equations] for the purpose of illustrating different problems in sound, and in order to familiarise you with the wave that may exist along with the wave of distortion in any true elastic solid which is not incompressible. We ignore this condensational wave in the theory of light. We are sure that its energy, at all events, if it is not null, is very small in comparison with the energy of the luminiferous vibrations we are dealing with. But to say that it is absolutely null, would be an assumption that we have no right to make. When we look through the little universe that we know, and think of the transmission of electrical force, and of the transmission of magnetic force and of the transmission of light, we have no right to assume that there may not be something else that our philosophy does not dream of. We have no right to assume that there may not be condensational waves in the luminiferous ether. We only do know that any vibrations of this kind, which are excited by the reflection and refraction of light, are certainly of very small energy compared with the energy of the light from which they proceed. The fact of the case as regards reflection and refraction is this, that unless the luminiferous ether is absolutely incompressible, the reflection and refraction of light must generally give rise to waves of condensation. Waves of distortion may exist without waves of condensation, but waves of distortion cannot be reflected at the bounding surface between two mediums without exciting in each medium a wave of condensation. When we come to the subject of reflection and refraction, we shall see how to deal with these condensational waves, and find how easy it is to get quit of them by supposing the medium to be incompressible. But it is always to be kept in mind as to be examined into, are there or are there not very small amounts of condensational waves generated in reflection and refraction, and may, after all, the propagation of electric force be by these waves of condensation?

"Suppose that we have at any place in air, or in luminiferous ether (I cannot distinguish now between the two ideas) a body that, through some action we need not describe, but which is conceivable, is alternatively positively and negatively electrified; may it not be that this will give rise to condensational waves? Suppose, for example, that we have two spherical conductors united by a fine wire, and that an alternating electromotive force is produced in that fine wire, for instance by an 'alternate current' dynamo-electric machine; and suppose that sort of thing goes on away from all other disturbance—at a great distance up in the air, for example. The result of the action of the dynamo-electric machine will be that one conductor will be alternately positively and negatively electrified, and the other conductor negatively and positively electrified. It is perfectly certain, if we turn the machine slowly, that in the air in the neighbourhood of the conductors we shall have alternately positively and negatively directed electric force with reversals of, for example, two or three hundred per second of time with a gradual transition from negative through zero to positive, and so on; and the same thing all through space; and we can tell exactly what the potential and what the electric force is at each instant at any point. Now, does any one believe that, if that revolution were made fast enough, the electro-static law of force, pure and simple, would apply to the air at different distances from each globe? Every one believes that if that process be conducted fast enough, several million times, or millions of million times per second, we should have large deviations from the electro-static law in the distribution of electric force through the air in the neighbourhood. It seems absolutely certain that such an action as that going on would give rise to electrical waves. Now it does seem to me probable that those electrical waves are condensational waves in luminiferous ether; and probably it would be that the propagation of these waves would be enormously faster than the propagation of ordinary light waves.

"I am quite conscious, when speaking of this, of what has been done in the so-called electro-magnetic theory of light. I know the propagation of electric impulse along an insulated wire surrounded by gutta-percha, which I worked out

myself about the year 1854, and in which I found a velocity comparable with the velocity of light. We did not then know the relation between electro-static and electro-magnetic units. If we work that out for the case of air instead of gutta-percha we get simply v (that is, the number of electro-static units in the electro-magnetic unit of quantity) for the velocity of propagation of the impulse. That is a very different case from this very rapidly varying electrification I have ideally put before you, and I have waited in vain to see how we can get any justification of the way of putting the idea of electric and magnetic waves in the so-called electro-magnetic theory of light.

"I may refer to a little article of mine in which I gave a sort of mechanical representation of electric, magnetic, and galvanic forces—galvanic force I called it then, a very badly-chosen name. It is published in the first volume of the reprint of my papers. It is shown in that paper that the static displacement of an elastic solid follows exactly the laws of the electro-static force, and that rotatory displacement of the medium follows exactly the laws of magnetic force. It seems to me that an incorporation of the theory of the propagation of electric and magnetic disturbances with the wave theory of light is most probably to be arrived at by trying to see clearly the view that I am now indicating. In the wave theory of light, however, we shall simply suppose the resistance to compression of the luminiferous ether, and the velocity of propagation of the condensational wave in it, to be infinite. We shall sometimes use the words 'practically infinite' to guard against supposing these quantities to be absolutely infinite."

The second extract which I give is from p. 143 of the Papyrograph edition of the "Baltimore Lectures"—a portion not yet reprinted.

"The want of indication of any such actions is sufficient to prove that if there are any in nature, they must be exceedingly small. But that there are such waves, I believe, and I believe that the velocity of propagation of electro-static force is the unknown condensational velocity that we are speaking of.

"I say 'believe' here in a somewhat modified manner. I do not mean that I believe this as a matter of religious faith, but rather as a matter of strong scientific probability."

J. T. BOTTOMLEY.

13 University Gardens, Glasgow, January 16.

The Astronomical Theory of the Ice Age.

MAY I first acknowledge the gentle kindliness with which my early teacher and friend, Sir Robert Ball, has pointed out my error in quoting from the old edition of his work. I much regret that I did not make further inquiries, but I was satisfied when the library clerks at Trinity College, Dublin, told me that if there had been any alteration in the text, they would have received a copy of the second edition. It appeared from Sir H. Howorth's letter that the mistake originated with the publishers, who erroneously informed the library agent that the second edition was a mere reprint, and therefore refused to supply a copy.

Both Sir Robert Ball and Dr. Wallace, in their letters in NATURE of January 9, have misunderstood the way in which I present my argument. If Dr. Wallace would read my papers again, I think he will see that, so far as I am concerned, the whole of his letter is founded on a complete misapprehension; and Sir Robert Ball will, I hope, also agree that he has somewhat altered the form in which I have stated my conclusions, and that I have fully recognised the difference which he thinks I have ignored. But as the matter really at issue is the present position of the astronomical theory, I may be excused from discussing this misunderstanding further, for even if every word of their criticisms on my conclusions were valid, the astronomical theory, *as it issued from the labours of Croll and Ball*, would be in no better position than before. Whether I am right or wrong in my belief that the astronomical factor cannot have been the principal one, I venture to think there can be no doubt that the existing exposition of that theory must be given up.

The foundation of the astronomical theory is the fall in temperature *directly* due to diminished sun-heat. Croll and Ball accordingly give calculations which indicate a large fall. Croll gets 45·3° F. for the lowering of mid-winter temperature in Great Britain during the long excentric winter, and Ball's modification of Croll's method gives about 25° F. as the lowering of the winter temperature. The first five pages of my article in the *Phil. Mag.* for December 1894 are devoted to showing that there is no justification for the principle on which this calculation is made, and that the fall must be a mere fraction of that postulated in either exposition of the astronomical theory. The chief flaw in the calculation is, curiously enough, that which Sir Robert and Dr. Wallace erroneously attribute to me, viz. that of considering that changes in terrestrial temperature are directly proportional to the changes in sun-heat, and ignoring the important element of storage and transference by ocean and air currents. How unsafe this is may be judged from the fact that if the method used to calculate the temperature in the Glacial Age from that in the present day were applied to find the summer temperature from the winter temperature, we should find for the British Isles a summer temperature of above 300° F. if we take Ball's hypothesis, and some thousands of degrees Fahrenheit if we take Croll's. If we calculate the winter temperature from the summer one, we should get − 125° F. for our winter temperature. A method which gives results in such striking contrast to the truth can hardly be accepted as a basis for a scientific theory.

If, therefore, this first portion of my criticism be correct (and hitherto no attempt has been made to refute it) the astronomical hypothesis is in just the position it would occupy if neither Croll's nor Ball's book had been written. So far, *the hypothesis itself* may be true or false; it is only the *reasoning* which has been put forward in its support that has to be abandoned or modified. The theory is, as all will admit, a tempting one, and accordingly I sought for some other means of establishing it. After several fruitless efforts to hit on a fairly satisfactory method of estimating the *direct* effect of an altered distribution of sun-heat on terrestrial temperatures, the method which Prof. Darwin has described occurred to me, and from it, *combined with a discussion on the transference of heat by the Gulf Stream* (see *Phil. Mag.* December 1894, p. 548 and p. 551), I was led to infer that for the British Isles at least the glaciation could not with any degree of probability be attributed to the long winter of great excentricity.

Sir Robert Ball's views, as presented in his letter, seems to involve a return to Croll's point of view, at least to the extent that the purely astronomical reason requires to be supplemented by a discussion of the oceanic and atmospheric currents. This view appears to me a true one; the only hope for the astronomical theory would be to show that the adjustment of terrestrial temperatures by the interaction of ocean and air currents with direct sun-heat is such that a very slight alteration of sun-heat produces a very great alteration of temperature; so that if the sun-heat which falls on Cornwall in winter were to be reduced to that which falls on Yorkshire, with corresponding changes for the temperate latitudes, and somewhat greater ones for the tropical belt, the ultimate result would be an Ice Age. But how can we hope to establish such a theory when we remember what a comparatively small change of temperature is due to the far greater changes of sun-heat from equator to pole as summer gives way to winter? EDWD. P. CULVERWELL.

Trinity College, Dublin, January 14.

Changes of Length in Bars and Wires of Magnetic Material due to Magnetisation.

THE appearance of a paper, by Dr. L. T. More, on the changes in length produced in iron wires by magnetisation (*Phil. Mag.*, October 1895, p. 345, and *Physical Review*, vol. iii. p. 210), has drawn my attention to a curious divergence of opinion on a fundamental point in magnetism. Dr. More has attempted to analyse the change of length accompanying magnetisation into a "*direct action*" which "may possibly be due to the orienting of the magnetised particles," and to "indirect actions." He adds (p. 224): "These indirect actions are the mechanical stresses created in the rod by the magnetism. The first of these . . . is the tractive force of the magnet and is measured by $B^2/8\pi$. That this force exists, tending always to *contract* the rod (italics mine), is seen from the fact that if the magnet is cut in two, the ends are held together. . . . This effect for high intensities of magnetisation is a large one, and becomes one of the most important factors in the observed changes in length." The stress referred to by Dr. More is that usually associated with the name of Maxwell ("Electricity and Magnetism," vol. ii. Arts. 641 *et seq.* *Cf.* Ewing, "Magnetic Induction in Iron and other Metals," § 147).

The first to propound the view adopted by Dr. More—that the mechanical force tends to *shorten* the rod—would seem to be

Mr. Shelford Bidwell (*Phil. Trans.*, 1888, pp. 216–7). He has been followed by Prof. Ewing, on pp. 242–3 of his "Magnetic Induction."

On the other hand, Maxwell, *l.c.*, speaks of a *tension* along the lines of force, and even more explicit statements to the same effect are due to Kirchhoff (*Wied. Ann.*, Bd. 24, p. 52, and Bd. 25, p. 601) and Prof. J. J. Thomson ("Applications of Dynamics to Physics and Chemistry," p. 52). The latter says: ". . . there are the strains arising from Maxwell's distribution of stress. Kirchhoff has investigated the effect of this on a small soft iron sphere placed in a uniform magnetic field and has shown that it would produce an *elongation* . . . along the lines of force and a contraction at right angles to them. We may therefore assume that in general this distribution of stress causes an *expansion* . . . in the direction of the lines of force . . ." (italics mine).

Prof. Thomson's view was accepted and restated by myself in discussing the phenomena in cobalt (*Phil. Trans.*, 1890, p. 339). The fact that my views escaped Dr. More's notice is not surprising, but it is strange that he overlooked Prof. Thomson's statement, and that I overlooked Mr. Shelford Bidwell's. My belief now, as before, is that the view of Kirchhoff and J. J. Thomson is the correct one.

Let us take the case of a long iron bar magnet suspended vertically. Suppose it cut in two transversely at a section A; then, supposing the magnetism sufficiently intense, the lower portion will, we know, adhere to the upper until a considerable weight, W, is hung from the lower end, B. If w be the weight of AB, the magnetic force over A must balance $W + w$, acting downwards, and so must itself act upwards, or away from AB. In other words, the magnetic force across A acts precisely like the elastic stress across a section of a rope fastened at one end and pulled at the other. The rope, as every one will realise, is under tension not pressure, and so clearly is the iron bar.

A more general way of looking at the matter is as follows:

A′ A B B′

$-m$ | $+m$ $-m$ | $+m$

Take imaginary sections A and B of a long uniformly magnetised straight or bent bar, and regard coterminous surfaces AA′ and BB′ as separated by distances small compared to AB. Taking the usual elementary theory, we see the force acting on the distribution $+m$ over A is $F - F' + F''$ to the *left*, where F arises from $-m$ over A′, $-F'$ from $-m$ over B, and F'' from $+m$ over B′. Now clearly F' and F'' are approximately equal, and each is small compared to F, so that A is obviously pulled to the left. Similarly B is pulled to the right, or AB is under tension.

Of course if the bar, when supported horizontally on a frictionless table, were actually cut through at A, foreign material—a finger, for instance—inserted between the naturally coterminous surfaces A and A′ would experience compression. I cannot avoid the conclusion that Mr. Shelford Bidwell and Dr. More have fallen into confusion through regarding the problem from this point of view, forgetting that the surfaces supposed to attract one another have nothing between them to squeeze.

That the question is of vital importance to a true understanding of the phenomena in iron is unquestionable if Dr. More's experiments—which seem carefully designed—gave anything like the true results. A reversal of the sign in his correction $B^2\delta l/8\pi l$ in his tables I. to IV.—necessitated by the view I advocate—would completely alter the character of the physical deductions to be made. The occasion for the correction, I may add, is as clearly indicated by Mr. Shelford Bidwell as by Dr. More, but the experimental data obtained by the former led him to attach less importance to it.

It is not my intention to discuss the actual magnitude of the magnetic stress or of the consequent alteration in length. An interesting experimental paper on the former subject by Mr. E. Taylor Jones, with references to recent conflicting authorities, appeared in the *Phil. Mag.*, March 1895, pp. 254–267. I may say, however, that the theoretical importance of investigations such as those of Prof. J. J. Thomson into the mutual relationships of magnetism and elasticity renders it all the more desirable that any doubt as to the true nature of the experimental results should be removed. To be altogether satisfactory, these investigations require trustworthy magnetic and elastic data for one and the same specimen.

C. CHREE.

January 11.

The Metric System.

MR. BROOK-FOX does not state accurately, in his letter to NATURE of January 9, what passed in relation to legislation on the subject of Weights and Measures in British India in the years 1870–1871.

It is true that an Act was passed in April 1870, enabling the Governor-General in Council to require the use of the Metrical Weights and Measures by Government departments, railway or other companies, registered under the law relating to such companies, and persons exercising specified occupations or trades; but only after certain preliminary steps had been gone through.

This Act was disallowed by the then Secretary of State for India, the Duke of Argyll, who had at first authorised legislation on the subject, in the general direction given to this Act, but considered that the actual form in which the measure was passed went beyond his original instructions, as it might have been extended to the dealings of persons engaged in business or trade, and was otherwise considered to be too drastic. Objection was also taken to the inclusion of the metre as the standard of length, the original authority to legislate having been limited to the adoption of the kilogramme as the unit of weight.

Immediately on the receipt of the Secretary of State's disallowance of the Act of 1870, a new permissive Bill was prepared, extending only to the standard of weight, which was again stated to be the kilogramme, and of measures of capacity which are subsidiary to those of weight; and limited, as to the power of applying it, to the case of Government departments, municipal bodies, and railway companies.

This measure became law as Act xxxi. of 1871, and is still in force. But it has never been put into operation. This, however, was not the result of the Duke of Argyll's action, but of the change of policy that followed on Lord Mayo's most unfortunate murder. Had Lord Mayo lived, he would certainly have given effect to the Act, the importance of which he thoroughly recognised. His successor was of a different opinion, and the combination of circumstances that for the moment appeared to have rendered possible the introduction of a rational system of weights and measures into our Indian Empire, passed away, and has not yet returned.

As having had charge of the Bill of 1870, in the Council of the Governor-General, I may be permitted, in conclusion, to quote the words that I wrote twenty-five years ago with reference to the fears expressed by the Secretary of State as to the danger of precipitate action in such a matter as this.

"The history of this very Act regarding weights and measures, which has been under consideration in one form or other for not less than fourteen years, which in its last stage has taken seven or eight years in coming to maturity, and to carry out the provisions of which no measures have yet been taken, or can be taken in all probability for another year at least, seems to me to teach that the one thing perfectly certain in the future is that the progress made in giving effect to any change in the present case will be slow in a degree most painful to all who are concerned in it; and that what with active opposition, and what with indifference, this Act is far more likely to remain a dead letter on the statute book for an indefinite period, than to be brought into operation with improper haste."

January 13. RICHARD STRACHEY.

Marsupial with an Allantoic Placenta.

I HAVE just received from my friend and former pupil Mr. J. P. Hill, Demonstrator of Biology in the Sydney University, an advanced copy of the *Abstract of Proceedings* of the Linnean Society of New South Wales for November 27, in which he announces the discovery of a true allantoic and highly vascular placenta, of a discoidal and most probably deciduous type, in the Bandicoot (*Perameles obesula*).

In the second part of his magnificent "Forschungsreisen im Australien und dem malayischen Archipel," Prof. R. Semon has substantiated the discovery of apposition between the allantois and sub-zonal membrane in *Phascolarctus*, and shown that a fusion is effected. He points out that the fœtal appendages of that animal are of a type involving certain Marsupialia in a position intermediate between the Placentalia on one hand, and the Monotremata and Sauropsida on the other, and regards the earlier recognised Marsupial condition, in which the allantois is remote from the serous membrane, as secondary and associated with the loss of a respiratory function by that organ.

The condition described by Mr. Hill in *Perameles* is one of natural advance upon the Phascolarctus type, and the facts in proof of the intimacy of relationship between the Placentalia and Lower Mammalia now overlap, like those bearing on birds and reptiles—*i.e.* just as *Archæopteryx* may be regarded as an avian reptile, and the Odontorinthes as reptilian birds—so the *Phascolarctus* may be regarded as a Placental Marsupial, and those placentalia which develop a provisionally vascular yolk-sac extending to the serous-membrane as Marsupial if not Monotrematous Placentalia. Mr. Hill's discovery, coming close upon that of Woodward that the young of the Diprotodontia are found to develop at fewest five pairs of upper incisors, and of Thomas that a representative of the Epanorthidæ survives in South America, and at a time when the tooth-genesis of both Marsupialia and Placentalia is receiving exceptional attention, is as welcome as important, in assisting us to form a clearer conception of the inter-relationships between these mammals.

Mr. Hill's observation would appear to lend not a little support to the conclusion which has for years been steadily gaining ground (*cf.* NATURE, vol. xl. p. 420), that the allantoic placenta was primitively discoidal. In an accompanying letter, he informs me that he has more recently come into possession of a uterus containing an unattached blastodermic vesicle; and it is sincerely to be hoped that he will be able to furnish observations bearing directly upon the important question of the supposed primitively chorionic nature of the Mammalian placenta.

G. B. HOWES.

Royal College of Science, London, January 14.

The Origin of Plant Structures.

MAY I call attention to a serious omission, and reply to one or two points, in Mr. Barber's review of my book? He says: "Of the *inheritance* of such acquired characters there is no proof at all. We are offered instead the 'argument of coincidences' and the 'cumulative evidence of probabilities, which amounts to a moral conviction.' Clearly, before rejecting a well-established and widely applicable hypothesis, something more tangible is required" (NATURE, December 19, 1895, p. 145).

First, with regard to inheritance. Mr. Wallace also asked for some proof of this; and I reply again that nature herself supplies it; for plant structures *are* reproduced by seed every year. It is the previous question, "How have they arisen?" with which I am concerned. But I *have*, in fact, given plenty of cases: as in my experiment with *Ononis*, Buckman's parsnip, Flahoult's with alpine plants, &c.

Moreover, the objector should state whether he means that any altered features in a plant should be reproduced by seed irrespective of the environment, or not. If a plant changes under new conditions—as ample experience shows it may—of course all its offspring will follow suit, under the same environment, irrespective of heredity; and if the conditions be maintained long enough, *then* the new features will tend to become relatively fixed, as all cultivators know. As long, however, as a natural environment is constant, no varieties are, as a rule, to be expected. Under cultivation, this rule does not hold good. Thus, *e.g. Brassica oleracea* gives rise to no varieties in nature; but there are very many fixed and hereditary races in artificial soils.

Secondly, the truth of an hypothesis or deduction cannot be more surely established than by "verification by experiment." Thus, with desert, aquatic, alpine, maritime, and other plants, I not only established the truth of my contention by *induction*, but have given the experimental verifications both of others and myself. For *this* fact Mr. Barber gives me no credit. It is in these two lines of proof, viz. by *induction* and *experiment*, that the theory of "the origin of species by means of natural selection" is wanting. It is, as Mr. Barber says, based on an "assumption," and is an *à priori* deduction that, because plants can vary indefinitely under cultivation, therefore they do so also in nature. *This has never been verified.*

Mr. Barber adds: "It is usually agreed that, from the nature of the case, a definite proof of the action of natural selection is difficult, if not impossible, in the present state of our knowledge." Is not this a most damaging admission? If the word "present" has to cover the thirty-six years since the "Origin" appeared, it would seem to be about time to abandon the theory even as a working hypothesis. The "wideness of its application" is no test of the truth of a deduction; for though natural selection may account for all organic structures, it can only do so because it is *assumed* that it can account for them. Herein it agrees precisely with the theory of special creations; which is equally assumed to be capable of accounting for every organic structure.

Mr. Barber tells me that I show a want of good taste in "narrowing" Darwin's field of observation. I much regret that anything I have written should be regarded as uncourteous; but it is Darwin himself who admits the "imputation," for he wrote: "I will give in detail all the facts which I have been able to collect," *i.e.* of "definite action" in plants, and mentions about thirty instances which he had heard of. He did not believe in definite variation being the rule in nature.

Lastly, I make no claim "to reconstruct the theory of evolution." All I have done is to take the following passage of Mr. Herbert Spencer's Essay on "The Development Hypothesis" (published in 1852, seven years before Darwin's "Origin" appeared) as my subject; and I have simply verified its profound truth in its application to plants. "The supporters of the developmental hypothesis can show . . . that any existing species—animal or vegetable—when placed under conditions different from its previous ones, immediately begins to undergo certain changes of structure fitting it for the new conditions . . . that in successive generations these changes continue until ultimately the new conditions become the natural ones. . . . They can show that throughout all organic nature there is at work a modifying influence of the kind they assign, as the causes of . . . specific differences; an influence which, though slow in its action, does in time, if the circumstances demand it, produce marked changes."

GEORGE HENSLOW.

I AM sorry I cannot agree with Prof. Henslow as to the nature of the proof required of him.

The fact that "plant structures *are* reproduced by seed every year" in nature is surely no proof of the inheritance of acquired characters!

Plants are, it is true, exceedingly plastic structures, and, as all allow, are both temporarily and permanently affected by their surroundings. This, if we needed further proof, Prof. Henslow has repeatedly demonstrated by his interesting series of facts. There seems to be danger, however, of confusing these *changes in the individual* with *changes in the race*. Prof. Henslow makes the former the prelude to the latter; and the first question to be settled is, What connection is there between these two classes of changes? In other words, Are acquired characters hereditary?

The issue is the same if we seek for the *causes of variation*. Darwinism, realising that there is a gradual adaptation of plants to altered surroundings, explains the fact by the *indirect* influence of the environment acting through natural selection. Among plants, which are stimulated to vary in all directions under change of conditions, those are preserved which vary so as to place themselves in adaptation to their new surroundings. Prof. Henslow substitutes the *direct* influence of the environment upon the *individual* plant, and asserts that the changes thus induced "become relatively fixed if the conditions are maintained long enough." Here is an assumption that the *change in the race* is the outcome of the *direct effect of the environment upon the individual*, or, again, that acquired characters are hereditary. I have carefully re-examined the cases mentioned of *Ononis*, parsnips and alpine plants, but cannot trace any proof of this assumption.

As to the *indefinite variation* of plants and animals in nature, it is difficult to conceive of doubt upon the subject. It is a common saying that "no two blades of grass are alike," although conditions could hardly be imagined more uniform than those in one and the same field. Moreover, the fact of indefinite variation has been fully proved by Prof. Wallace in his work on Darwinism. In chapter iii., on "Variability of Species in a State of Nature," the whole subject has been exhaustively dealt with, and I cannot do better than refer Prof. Henslow to that chapter, where numerous cases are given, both in animals and plants. I would especially refer to the extracts from Darwin's note-books there published for the first time.

I do not quite follow Prof. Henslow in rejecting evidence drawn from cultivated plants. Placing wild forms under cultivation is a severe change of environment, and any such change induces, of itself, a great tendency to vary. The influences which work slowly in nature are intensified; and the substitution

of artificial instead of natural selection further increases the rapidity of the results.

It must be borne in mind, too, that plants under cultivation are not necessarily grown for successive generations under the same conditions. While the change from the wild state to cultivation is as slight in some cases as it is profound in others, plants under continued cultivation are frequently subject to a succession of changes of environment as to soil, locality, water, manure, &c.: and we should therefore, according to well-known laws, expect to obtain a greatly increased number of variations in them. And these variations, as elsewhere, are coupled with a strong hereditary tendency, thus producing many new varieties.

Lastly, as regards the quotation from Mr. Herbert Spencer's essay, its terms are not at all inimical to natural selection, but apply to it equally well—a remark which, I cannot but feel, also applies to the bulk of Prof. Henslow's work. C. A. B.

A Remarkable Discharge of Lightning.

[THE following letter was sent to the Royal Society, and has been forwarded to us by the Secretary.—ED. NATURE.]

I THINK it may interest you to know that an extraordinary flash of lightning was witnessed from this place, this evening, at 7.38 p.m. It has been raining in torrents nearly all day long; the heavens seem heavy and saturated with rain, but we have had no thunder at all.

Now the undersigned were seated round a table in a room in Fife Street, and only one of us had his eyes turned in the direction of the door, which was open. Suddenly he exclaimed, "Good heavens! just look at that lightning; it's standing still!"

All of us promptly went to the door, whence we witnessed a truly extraordinary sight in the shape of three ribbons of a greenish white lightning, which hung in the sky, motionless, for what must have been fifteen to twenty seconds. It seemed to be a long way off (in a north-westerly direction), as we heard no report of thunder whatever. We put some questions to our Makalaka boy, who said that he had never seen anything like it in all his life.

There could be no mistake about it—it was as distinct as possible; and it must have lasted fifteen seconds *at least* (I should say twenty myself). I can refer you (should you desire to know more of me) to John Chumley, Esq., Manager of the Standard Bank of South Africa, Limited, 10 Clement's Lane, London, E.C.; Major W. E. Gilbert, Warleigh Lodge, Upper Tulse Hill; or John Heal, Esq., Hertford Lodge, Church End Finchley, London, N. ROB. GODLONTON.

The undersigned were witnesses of the stroke of forked lightning described in the letter to you, written by Mr. Godlonton, and consider his description accurate in every detail.

CHAS. HONEY (care of F. A. Purdon, Esq., Buluwayo).
OTTO BERTRAM (Standard Bank, Buluwayo).
ROB. GODLONTON (Secretary Matebeleland Printing and Publishing Company, Limited, Buluwayo).

December 2, 1895.

Lecture Experiments on the Nodes of a Bell.

I WAS much interested in the communication from Mr. Osborn on the above subject (see NATURE, January 9). For some years I have been in the habit of showing these nodes in the following way. An ordinary glass bell-jar, eight or ten inches high, with a moderately broad, flat, ground edge, is held with the edge upright, and fine sand scattered all over the flat edge. It is comparatively easy to excite the edge with a bow in such a way that the sand will be driven off everywhere except at the four nodes. I have never been able, however, to obtain more than four nodes in this way.

I have also employed a similar method for showing the nodes of a tuning-fork. If the fork is a moderately large one, it is held horizontally in the hand, and the upper prong is covered with sand. By bowing sharply near the middle and near the root of the prongs, two overtones can usually be obtained, the nodes of which are clearly marked by the sand.

Central School, Manchester. R. L. TAYLOR.

THE STATUS OF LONDON UNIVERSITY.

PROF. S. P. THOMPSON'S lecture to the Society of Arts on the 15th inst. will greatly assist the scheme for the reform of the University of London. The statistics brought forward by him show how hopelessly inadequate the equipment of the present University appears when compared with that of almost any other University in the world. It can hardly be believed that while Strassburg receives State aid to the extent of £44 per annum for each student, the University of London actually *pays the State* ten shillings for each student. As the lecturer remarked, a University which has no professors, no museums, no laboratories for research, whose library is practically unused and unusable, and whose sole function is to examine, cannot be called a *great* University, if, indeed, it be rightly entitled to be called a University at all. Limits of space prevent us from reprinting Prof. Thompson's paper, but we give, on the following page, a table prepared by him to exhibit the material and financial aspects of different Universities. This information, and Lord Reay's remarks upon the paper, should do much to controvert dialectic denunciations, and to show the true position of London University among the Universities of the world.

Prof. Thompson considered in succession the points upon which information is given in the different columns of his tabulated statement. He showed that not only is the educational position of the existing University entirely anomalous, but the financial position is still more extraordinary.

In closing the discussion which followed the reading of Prof. Thompson's paper, the Chairman, Lord Reay, remarked that the statistics which it included could not be too much impressed on the public mind, as an indictment against the country for leaving waste resources unparalleled in the civilised world. He was quite convinced that, if there were in any other country the treasures we had in London, both in the way of museums and libraries, and of men who were prepared to teach, it would not take ten, twelve, or twenty years to bring about the result required: but that whoever was the director of public instruction in that country would at once say to the Minister that it was his duty to lay on the table of the Legislature a Bill for the establishment of a teaching university. Among the many extraordinary symptoms which this controversy had brought to the surface, there was one of a very curious nature. Whenever they read an argument against the creation of such a university they found, either outspoken or in a latent form, this accusation: "Such a scheme will hand us over to the tender mercies of the London teachers." Now to the tender mercies of the teachers higher education was left in all the countries of Europe. He was not yet acquainted with the constitution of the University of Tokio, but he should be much surprised if they found there the slightest jealousy of leaving to the teachers the management of that which they must understand better than others. As a member of the Cowper Commission, he had been agreeably surprised to find that amongst all those on whose opinion the Commission set most store, there had been hardly a dissentient voice. In the case of every former report or scheme, those who would have had to put it in operation, and on whose labours its success depended, were in doubt, not about details, but about some leading feature; but this last scheme had been accepted not only by the teachers in London, but by the staffs of those very provincial schools whose students, they were told, in some questions had not been sufficiently considered. The best answer to the difficulty about external students was that given by Prof. Thompson when he said that learning, not teaching or examining, was the primary essential. That meant that, in a teaching university, the individuality of the teacher should be allowed its full scope, and also that each individual student should be allowed to work for the sake of learning, not for the sake of the examination. There might be as much difference between two internal students as between an internal student and an external, and in the examination the individual character of each student would be allowed for. The external students would not only have the same guarantees of a fair examination as at present, but perhaps even better; but if further guarantees were wanted, by all means let them be given. The great point was that internal students of London should, at least, have that to which they had a right—a teaching university of their own. It was nothing less than a scandal that London, with a greater population than Scotland, or than many of the countries of Europe, which had two or three universitie, should not have a university of its own.

With regard to the question of the boundary line, every one who had had any experience in such questions knew that controversy was endless, but that was a matter for the Statutory Commission, and the subjects to be included in the curriculum were also open; but agriculture was expressly included, because it was found that at most universities the science of agriculture, apart from its practical aspect, was deemed essential. He thought it was not only the duty, but the privilege of any Government of this country to at least give to the metropolis and to the empire a worthy university.

	Gross Income.	State or Municipal Subvention.	No. of Students.	Income per Student.	State, &c., Subvention per Student.	No. of Professors and Assistants.	Total Salaries of Teachers.	Total sum spent on Museums, Laboratories, Observatories, and Institutes per annum.	Total Sum spent on Library per annum. Staff.	Books.
	£	£		£	£		£	£	£	£
Paris	150,000	?	11,233	13	?	300 +	116,000	34,000	4,100	2,700
Berlin	130,000	105,000	8,652	15	12	179 + 174	34,000	73,000	1,600	950
Vienna	109,000	104,000	6,714	16	15	159 + 190	25,000	12,600	1,080	930
Oxford { Univ. Colls.	63,761 250,000	—	3,200 (under-grads.)	19 77	—	70 +	?	12,000	4,762	5,238
Cambridge { Univ. Colls.	65,550 282,000	—	2,900 (under-grads.)	22 97	—	80 +	?	9,000	4,000	2,040
Harvard ...	260,000	—	3,783	69	—	149 + 188	101,000	88,000	4,200	5,000
Leipzig	90,000	70,000	2,957	34	23	134 + 65	46,000	24,500	2,000	2,500
Edinburgh ...	88,142	29,752	2,924	30	10	90 +	48,000	19,000	1,012	1,400
London	21,000	†	2,225	9	‡	—	—	199	?	100
Cornell	105,000	7,000	1,686	62	4	77 + 80	54,000	21,300	7,600	
Padua	26,800	?	1,672	16	?	62 + 60	20,000	4,800	1,000	400
Graz	19,800	18,600	1,562	13	12	83 + 28	10,000	9,000	2,200	
Upsala	40,000	9,000	1,495	27	6	122	24,300	8,900	1,200	
Bologna... ...	30,000	?	1,457	20	?	70 + 81	20,000	9,000 (?)	680	400
Heidelberg ...	38,400	34,500	1,428	27	24	96 + 25	23,000	13,000	?	800
Tokio	70,000(?)	?	1,396	50 (?)	?	123 + 31	25,000(?)	?	?	?
Tübingen ...	45,000	43,000	1,262	36	34	69 + 15	20,000	23,000	?	700
Dublin (Trinity College) ...	70,000	—	1,124	62	—	35 +	?	?	?	
Strassburg ...	50,000	46,000	1,030	48	44	88 + 32	26,000	16,000	2,800	2,950
Greifswald ...	39,000	14,000	891	43	17	64 + 22	13,000	19,000	1,000	2,000
Zürich *... ...	30,000	25,000(?)	822	36	30 (?)	61 + 56	9,500	3,500	[1,150]	
Leyden	62,200	?	815	76	?	50 + ?	33,000	4,680	445	780
Königsberg ...	49,000	41,000	756	66	55	70 + 32	15,000	25,000	1,300	1,370
Giessen	38,000	27,000	598	63	45	55 + 8	13,000	22,000	570	900
Baltimore ...	35,000	—	589	59	—	42 + 42	?	10,300 (?)	?	
Rostock... ...	16,000	15,000	420	38	36	42 + 3	7,900	5,500	400	1,030
St. Andrews ...	11,972	6,035	199	60	30	15 + 4	10,000	?	630	

* This does not include the Polytechnicum, which has an income of £36,000, of which £30,000 is a Subvention from Government, and which has 1,235 Students, and spends £6,500 a year on its Laboratories for Chemistry, Physics, Engineering, &c.
† Instead of receiving a Subvention, London University *pays to the State* £1,102 per annum.
‡ London University *pays to the State* a sum equivalent to 10*s*. per student.

VOTE OF CONVOCATION ON THE COWPER COMMISSION SCHEME.

ANOTHER step has been taken in the long controversy with respect to the equipment of the University of London with teaching functions. While the other bodies represented on the recent deputation to the Duke of Devonshire had passed resolutions asking the Government to introduce a Bill similar to Lord Playfair's "London University Commission Bill, 1895," but with an added clause giving a right of appeal to the Privy Council (NATURE, December 5, 1895), Convocation had not expressed any opinion either on the Bill or on the proposed appeal, owing to Lord Playfair's Bill being introduced into the House of Lords too late to allow of a resolution approving its terms to be moved at the last meeting in May. On Tuesday last, the Annual Committee recommended Convocation to adopt the following resolution: "That this House desires the early introduction into Parliament of a Bill for the reconstitution of the University similar to that introduced last year by Lord Playfair, but with an inserted clause securing to the Senate, to Convocation, and to other bodies affected, the right of appeal to the Privy Council on any of the provisions which may hereafter be settled by the Statutory Commission." This resolution was carried by 470 votes against 244, and thus for the third time Convocation, in the only legal way, has pronounced decisively in favour of the Cowper Commission scheme. The progressive rise in the majorities is not the least satisfactory feature of the struggle in Convocation—a majority of 24 in a house of 290 in January of last year rose to 122 in a house of 354 in May, and has now become 226 in a house of 714. The next step rests with the Government, but in view of the remarkable unanimity existing among the bodies affected by the scheme, and the universally favourable attitude of the metropolitan press towards it, we can be in no doubt as to what the final settlement must be.

ON A NEW KIND OF RAYS.[1]

(1) A DISCHARGE from a large induction coil is passed through a Hittorf's vacuum tube, or through a well-exhausted Crookes' or Lenard's tube. The tube is surrounded by a fairly close-fitting shield of black paper; it is then possible to see, in a completely darkened room, that paper covered on one side with barium platinocyanide lights up with brilliant fluorescence when brought into the neighbourhood of the tube, whether the painted side or the other be turned towards the tube. The fluorescence is still visible at two metres distance. It is easy to show that the origin of the fluorescence lies within the vacuum tube.

(2) It is seen, therefore, that some agent is capable of penetrating black cardboard which is quite opaque to ultra-violet light, sunlight, or arc-light. It is therefore of interest to investigate how far other bodies can be penetrated by the same agent. It is readily shown that all bodies possess this same transparency, but in very varying degrees. For example, paper is very transparent; the fluorescent screen will light up when placed behind a book of a thousand pages; printer's ink offers no marked resistance. Similarly the fluorescence shows behind two packs of cards; a single card does not visibly diminish the brilliancy of the light. So, again, a single thickness of tinfoil hardly casts a shadow on the screen; several have to be superposed to produce a marked effect. Thick blocks of wood are still transparent. Boards of pine two or three centimetres thick absorb only very little. A piece of sheet aluminium, 15 mm. thick, still allowed the X-rays (as I will call the rays, for the sake of brevity) to pass, but greatly reduced the fluorescence. Glass plates of similar thickness behave similarly; lead glass is, however, much more opaque than glass free from lead. Ebonite several centimetres thick is transparent. If the hand be held before the fluorescent screen, the shadow shows the bones darkly, with only faint outlines of the surrounding tissues.

Water and several other fluids are very transparent. Hydrogen is not markedly more permeable than air. Plates of copper, silver, lead, gold, and platinum also allow the rays to pass, but only when the metal is thin. Platinum ·2 mm. thick allows some rays to pass; silver and copper are more transparent. Lead 1·5 mm. thick is practically opaque. If a square rod of wood 20 mm. in the side be painted on one face with white lead, it casts little shadow when it is so turned that the painted face is parallel to the X-rays, but a strong shadow if the rays have to pass through the painted side. The salts of the metals, either solid or in solution, behave generally as the metals themselves.

(3) The preceding experiments lead to the conclusion that the density of the bodies is the property whose variation mainly affects their permeability. At least no other property seems so marked in this connection. But that the density alone does not determine the transparency is shown by an experiment wherein plates of similar thickness of Iceland spar, glass, aluminium, and quartz were employed as screens. Then the Iceland spar showed itself much less transparent than the other bodies, though of approximately the same density. I have not remarked any strong fluorescence of Iceland spar compared with glass (see below, No. 4).

(4) Increasing thickness increases the hindrance offered to the rays by all bodies. A picture has been impressed on a photographic plate of a number of superposed layers of tinfoil, like steps, presenting thus a regularly increasing thickness. This is to be submitted to photometric processes when a suitable instrument is available.

(5) Pieces of platinum, lead, zinc, and aluminium foil were so arranged as to produce the same weakening of the effect. The annexed table shows the relative thickness and density of the equivalent sheets of metal.

	Thickness.	Relative thickness.	Density
Platinum	·018 mm.	1	21·5
Lead	·050 ,,	3	11·3
Zinc	·100 ,,	6	7·1
Aluminium	3·500 ,,	200	2·6

From these values it is clear that in no case can we obtain the transparency of a body from the product of its density and thickness. The transparency increases much more rapidly than the product decreases.

(6) The fluorescence of barium platinocyanide is not the only noticeable action of the X-rays. It is to be observed that other bodies exhibit fluorescence, *e.g.* calcium sulphide, uranium glass, Iceland spar, rock-salt, &c.

Of special interest in this connection is the fact that photographic dry plates are sensitive to the X-rays. It is thus possible to exhibit the phenomena so as to exclude the danger of error. I have thus confirmed many observations originally made by eye observation with the fluorescent screen. Here the power of the X-rays to pass through wood or cardboard becomes useful. The photographic plate can be exposed to the action without removal of the shutter of the dark slide or other protecting case, so that the experiment need not be conducted in darkness. Manifestly, unexposed plates must not be left in their box near the vacuum tube.

It seems now questionable whether the impression on the plate is a direct effect of the X-rays, or a secondary result induced by the fluorescence of the material of the plate. Films can receive the impression as well as ordinary dry plates.

[1] By W. C. Röntgen. Translated by Arthur Stanton from the *Sitzungsberichte der Würzburger Physik-medic. Gesellschaft*, 1895.

I have not been able to show experimentally that the X-rays give rise to any calorific effects. These, however, may be assumed, for the phenomena of fluorescence show that the X-rays are capable of transformation. It is also certain that all the X-rays falling on a body do not leave it as such.

The retina of the eye is quite insensitive to these rays: the eye placed close to the apparatus sees nothing. It is clear from the experiments that this is not due to want of permeability on the part of the structures of the eye.

(7) After my experiments on the transparency of increasing thicknesses of different media, I proceeded to investigate whether the X-rays could be deflected by a prism. Investigations with water and carbon bisulphide in mica prisms of 30° showed no deviation either on the photographic or the fluorescent plate. For comparison, light rays were allowed to fall on the prism as the apparatus was set up for the experiment. They were deviated 10 mm. and 20 mm. respectively in the case of the two prisms.

With prisms of ebonite and aluminium, I have obtained images on the photographic plate, which point to a possible deviation. It is, however, uncertain, and at most would point to a refractive index 1·05. No deviation can be observed by means of the fluorescent screen. Investigations with the heavier metals have not as yet led to any result, because of their small transparency and the consequent enfeebling of the transmitted rays.

On account of the importance of the question it is desirable to try in other ways whether the X-rays are susceptible of refraction. Finely powdered bodies allow in thick layers but little of the incident light to pass through, in consequence of refraction and reflection. In the case of the X-rays, however, such layers of powder are for equal masses of substance equally transparent with the coherent solid itself. Hence we cannot conclude any regular reflection or refraction of the X-rays. The research was conducted by the aid of finely-powdered rock-salt, fine electrolytic silver powder, and zinc dust already many times employed in chemical work. In all these cases the result, whether by the fluorescent screen or the photographic method, indicated no difference in transparency between the powder and the coherent solid.

It is, hence, obvious that lenses cannot be looked upon as capable of concentrating the X-rays; in effect, both an ebonite and a glass lens of large size prove to be without action. The shadow photograph of a round rod is darker in the middle than at the edge; the image of a cylinder filled with a body more transparent than its walls exhibits the middle brighter than the edge.

(8) The preceding experiments, and others which I pass over, point to the rays being incapable of regular reflection. It is, however, well to detail an observation which at first sight seemed to lead to an opposite conclusion.

I exposed a plate, protected by a black paper sheath, to the X-rays. so that the glass side lay next to the vacuum tube. The sensitive film was partly covered with star-shaped pieces of platinum, lead, zinc, and aluminium. On the developed negative the star-shaped impression showed dark under platinum, lead, and, more markedly, under zinc; the aluminium gave no image. It seems, therefore, that these three metals can reflect the X-rays; as, however, another explanation is possible, I repeated the experiment with this only difference, that a film of thin aluminium foil was interposed between the sensitive film and the metal stars. Such an aluminium plate is opaque to ultra-violet rays, but transparent to X-rays. In the result the images appeared as before, this pointing still to the existence of reflection at metal surfaces.

If one considers this observation in connection with others, namely, on the transparency of powders, and on the state of the surface not being effective in altering the passage of the X-rays through a body, it leads to the probable conclusion that regular reflection does not exist, but that bodies behave to the X-rays as turbid media to light.

Since I have obtained no evidence of refraction at the surface of different media, it seems probable that the X-rays move with the same velocity in all bodies, and in a medium which penetrates everything, and in which the molecules of bodies are embedded. The molecules obstruct the X-rays, the more effectively as the density of the body concerned is greater.

(9) It seemed possible that the geometrical arrangement of the molecules might affect the action of a body upon the X-rays, so that, for example, Iceland spar might exhibit different phenomena according to the relation of the surface of the plate to the axis of the crystal. Experiments with quartz and Iceland spar on this point lead to a negative result.

(10) It is known that Lenard, in his investigations on kathode rays, has shown that they belong to the ether, and can pass through all bodies. Concerning the X-rays the same may be said.

In his latest work, Lenard has investigated the absorption coefficients of various bodies for the kathode rays, including air at atmospheric pressure, which gives 4·10, 3·40, 3·10 for 1 cm., according to the degree of exhaustion of the gas in discharge tube. To judge from the nature of the discharge, I have worked at about the same pressure, but occasionally at greater or smaller pressures. I find, using a Weber's photometer, that the intensity of the fluorescent light varies nearly as the inverse square of the distance between screen and discharge tube. This result is obtained from three very consistent sets of observations at distances of 100 and 200 mm. Hence air absorbs the X-rays much less than the kathode rays. This result is in complete agreement with the previously described result, that the fluorescence of the screen can be still observed at 2 metres from the vacuum tube. In general, other bodies behave like air; they are more transparent for the X-rays than for the kathode rays.

(11) A further distinction, and a noteworthy one, results from the action of a magnet. I have not succeeded in observing any deviation of the X-rays even in very strong magnetic fields.

The deviation of kathode rays by the magnet is one of their peculiar characteristics; it has been observed by Hertz and Lenard, that several kinds of kathode rays exist, which differ by their power of exciting phosphorescence, their susceptibility of absorption, and their deviation by the magnet; but a notable deviation has been observed in all cases which have yet been investigated, and I think that such deviation affords a characteristic not to be set aside lightly.

(12) As the result of many researches, it appears that the place of most brilliant phosphorescence of the walls of the discharge-tube is the chief seat whence the X-rays originate and spread in all directions; that is, the X-rays proceed from the front where the kathode rays strike the glass. If one deviates the kathode rays within the tube by means of a magnet, it is seen that the X-rays proceed from a new point, *i.e.* again from the end of the kathode rays.

Also for this reason the X-rays, which are not deflected by a magnet, cannot be regarded as kathode rays which have passed through the glass, for that passage cannot, according to Lenard, be the cause of the different deflection of the rays. Hence I conclude that the X-rays are not identical with the kathode rays, but are produced from the kathode rays at the glass surface of the tube.

(13) The rays are generated not only in glass. I have obtained them in an apparatus closed by an aluminium plate 2 mm. thick. I purpose later to investigate the behaviour of other substances.

(14) The justification of the term "rays," applied to the phenomena, lies partly in the regular shadow pictures produced by the interposition of a more or less permeable

body between the source and a photographic plate or fluorescent screen.

I have observed and photographed many such shadow pictures. Thus, I have an outline of part of a door covered with lead paint; the image was produced by placing the discharge-tube on one side of the door, and the sensitive plate on the other. I have also a shadow of the bones of the hand (Fig. 1), of a wire wound upon a bobbin, of a set of weights in a box, of a

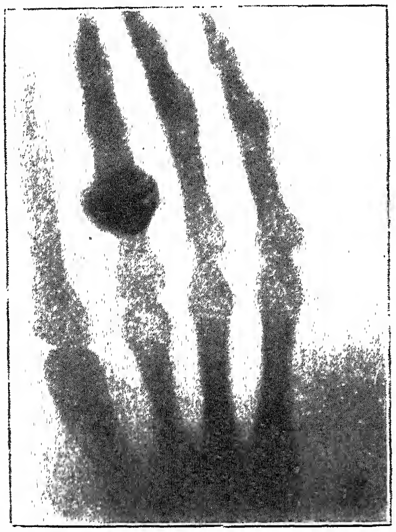

FIG. 1.—Photograph of the bones in the fingers of a living human hand. The third finger has a ring upon it.

compass card and needle completely enclosed in a metal case (Fig. 2), of a piece of metal where the X-rays show the want of homogeneity, and of other things.

For the rectilinear propagation of the rays, I have a pin-hole photograph of the discharge apparatus covered with black paper. It is faint but unmistakable.

(15) I have sought for interference effects of the X-rays,

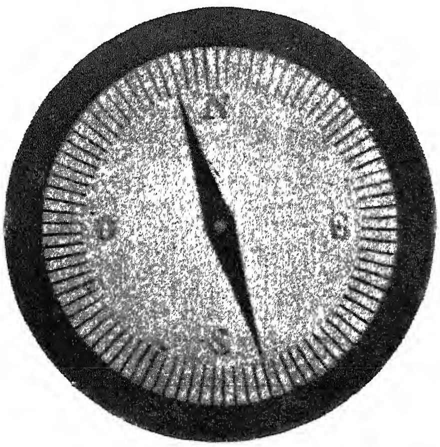

FIG. 2.—Photograph of a compass card and needle completely enclosed in a metal case.

but possibly, in consequence of their small intensity, without result.

(16) Researches to investigate whether electrostatic forces act on the X-rays are begun but not yet concluded.

(17) If one asks, what then are these X-rays; since they are not kathode rays, one might suppose, from their power of exciting fluorescence and chemical action, them to be due to ultra-violet light. In opposition to this view a weighty set of considerations presents itself. If X-rays be indeed ultra-violet light, then that light must possess the following properties.

(*a*) It is not refracted in passing from air into water, carbon bisulphide, aluminium, rock-salt, glass or zinc.

(*b*) It is incapable of regular reflection at the surfaces of the above bodies.

(*c*) It cannot be polarised by any ordinary polarising media.

(*d*) The absorption by various bodies must depend chiefly on their density.

That is to say, these ultra-violet rays must behave quite differently from the visible, infra-red, and hitherto known ultra-violet rays.

These things appear so unlikely that I have sought for another hypothesis.

A kind of relationship between the new rays and light rays appears to exist; at least the formation of shadows, fluorescence, and the production of chemical action point in this direction. Now it has been known for a long time, that besides the transverse vibrations which account for the phenomena of light, it is possible that longitudinal vibrations should exist in the ether, and, according to the view of some physicists, must exist. It is granted that their existence has not yet been made clear, and their properties are not experimentally demonstrated. Should not the new rays be ascribed to longitudinal waves in the ether?

I must confess that I have in the course of this research made myself more and more familiar with this thought, and venture to put the opinion forward, while I am quite conscious that the hypothesis advanced still requires a more solid foundation.

PROFESSOR RÖNTGEN'S DISCOVERY.

THE newspaper reports of Prof. Röntgen's experiments have, during the past few days, excited considerable interest. The discovery does not appear, however, to be entirely novel, as it was noted by Hertz that metallic films are transparent to the kathode rays from a Crookes or Hittorf tube, and in Lenard's researches, published about two years ago, it is distinctly pointed out that such rays will produce photographic impressions. Indeed, Lenard, employing a tube with an aluminium window, through which the kathode rays passed out with comparative ease, obtained photographic shadow images almost identical with those of Röntgen, through pieces of cardboard and aluminium interposed between the window and the photographic plate.

Prof. Röntgen has, however, shown that this aluminium window is unnecessary, as some portion of the kathode radiations that are photographically active will pass through the glass walls of the tube. Further, he has extended the results obtained by Lenard in a manner that has impressed the popular imagination, while, perhaps most important of all, he has discovered the exceedingly curious fact that bone is so much less transparent to these radiations than flesh and muscle, that if a living human hand be interposed between a Crookes tube and a photographic plate, a shadow photograph can be obtained which shows all the outlines and joints of the bones most distinctly.

Working upon the lines indicated in the telegrams from Vienna, recently published in the daily papers, I have, with the assistance of Mr. J. C. M. Stanton, repeated many of Prof. Röntgen's experiments with entire success. According to one of our first experiments, an ordinary gelatinous bromide dry photographic plate was placed in an ordinary camera back. The wooden shutter of the back was kept closed, and upon it were placed miscellaneous articles such as coins, pieces of wood, carbon, ebonite, vulcanised fibre, aluminium, &c., all being quite opaque to ordinary light. Above was supported a

Crookes tube, which was excited for some minutes. On development, shadows of all the articles placed on the slide were clearly visible, some being more opaque than others. Further experiments were tried with thin plates of aluminium or of black vulcanised fibre interposed between the objects to be photographed and the sensitive surface, this thin plate being used in place of the wood of the camera back. In this manner sharper shadow pictures were obtained. While most thick metal sheets appear to be entirely opaque to the radiations, aluminium appears to be relatively transparent. Ebonite, vulcanised fibre, carbon, wood, cardboard, leather and slate are all very transparent, while, on the other hand, glass is exceedingly opaque. Thin metal foils are moderately opaque, but not altogether so.

As tending to the view that the radiations are more akin to ultraviolet than to infra-red light, it may be mentioned that a solution of alum in water is distinctly more transparent to them than a solution of iodine in bisulphide of carbon.

So far as our own experiments go, it appears that, at any rate without very long exposures, a sufficiently active excitation of the Crookes tube is not obtained by direct connection to an ordinary Rhumkorff induction coil, even of a large size. So-called high frequency currents, however, appear to give good results, and our own experiments have been made with the tube excited by current obtained from the secondary circuit of a Tesla oil coil, through the primary of which were continuously discharged twelve half-gallon Leyden jars, charged by an alternating current of about 20,000 volts pressure, produced by a transformer with a spark-gap across its high-pressure terminals.

For obtaining shadow photographs of inanimate objects, and for testing the relative transparency of different substances, the particular form of Crookes tube employed does not appear to greatly signify, though some forms are, we find, better than others. When, however, the human hand is to be photographed, and it is important to obtain sharp shadows of the bones, the particular form of tube used and its position relative to the hand and sensitive plate appear to be of great importance. So far, owing to the frequent destruction of the tubes, due to overheating of the terminals, we have not been able to ascertain exactly the best form and arrangement for this purpose, except that it appears desirable that the electrodes in the tube should consist of flat and not curved plates, and that these plates should be of small dimensions.

The accompanying photograph of a living human hand (Fig. 1) was exposed for twenty minutes through an aluminium sheet ·0075 in thickness, the Crookes tube, which was one of the kind containing some white phosphorescent material (probably sulphide of barium), being held vertically upside down, with its lowest point about two inches above the centre of the hand.

By substituting a thin sheet of black vulcanised fibre for the aluminium plate, we have since been able to reduce the exposure required to four minutes. Indeed with the aluminium plate, the twenty minutes' exposure appears to have been longer than was necessary. Further, having regard to the great opacity of glass, it seems probable that where ordinary Crookes tubes are employed, a large proportion of the active radiations must be absorbed by the glass of the tube itself. If this is so, by the employment of a tube partly constructed of aluminium, as used by Lenard, the necessary length of exposure could be much reduced.

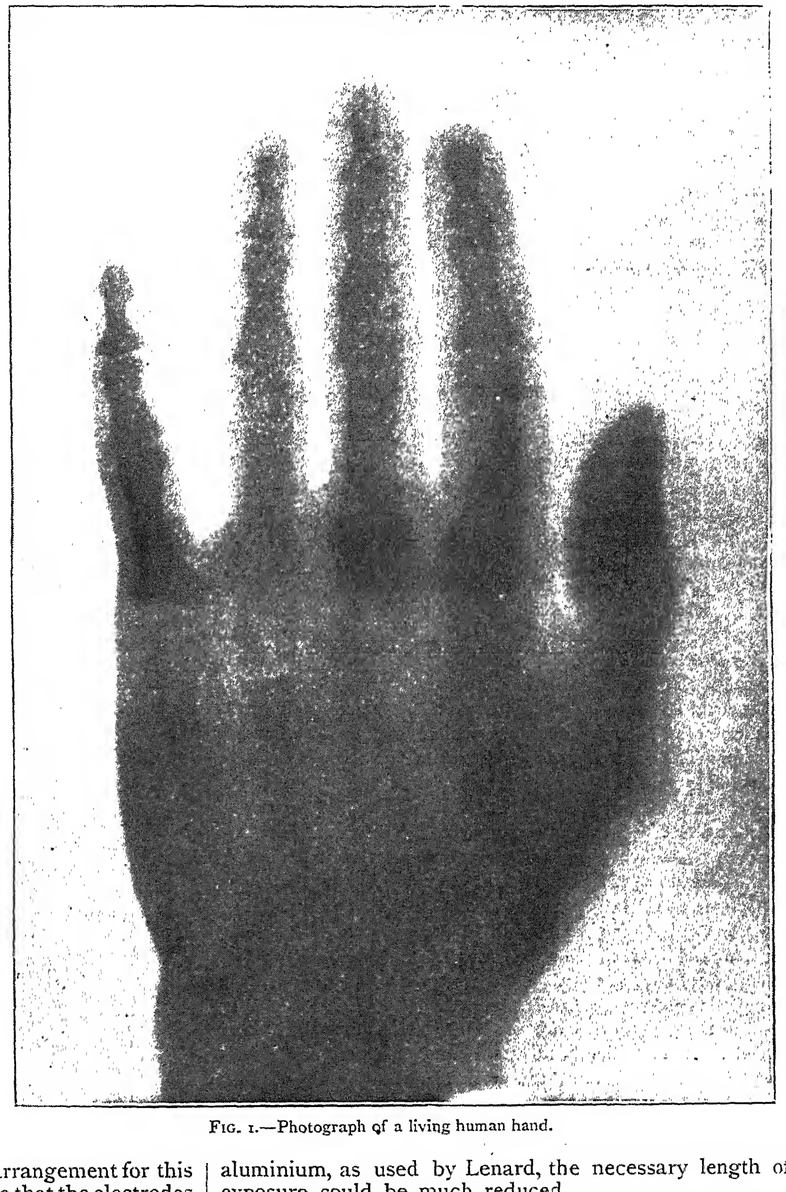

FIG. 1.—Photograph of a living human hand.

A. A. C. SWINTON.

NOTES.

AT their scientific meeting on March 3, the Zoological Society propose to discuss the much-vexed question of zoological nomenclature. This subject will be introduced by Mr. Sclater, the Secretary of the Society, who will read a paper on the "Rules for naming Animals," lately adopted by the German

Zoological Society, and point out the divergences between them and what is called the Stricklandian Code of Nomenclature, recognised by the British Association, and usually followed in this country.

THE question of technical and commercial attachés to British Embassies was referred to by the Right Hon. George Curzon, M.P., Under Secretary for Foreign Affairs, in the course of some remarks to the Wolverhampton Chamber of Commerce last week. He acknowledged that it is desirable, in many of those countries where our commercial connection is large, to have representatives whose attention is exclusively directed to our commercial interests. He also remarked that it appeared to his Department that the existing arrangement of the areas of our commercial attachés in Europe, of which there are three, is unscientific and imperfect. A technical attaché should be appointed in Germany, and our forces in other directions ought to be increased. But while he agreed that attachés with technical knowledge could be of great assistance in the development of British trade, and hoped that the Foreign Office would soon be able to do something to extend the Consular service in the desired direction, he thought that Chambers of Commerce should do more than they seem to do at present in furtherance of their own trades, by sending out commissions to distant parts to ascertain on the spot what are the particular points with which they have to contend, and the lines of possible development. This is typical of the kind of advice usually given by the British Government. It amounts to an acknowledgment of defects, but leaves private enterprise to supply the remedy. In this respect our Government differs in policy from those of France and Germany—two of our chief competitors in trade—for in those countries the State takes an active interest in the development of industries; and the knowledge which makes for such advancement, as well as the men who are competent to form an opinion upon industrial processes, are fully utilised. The Foreign Office exists for the promotion and fostering of British trade, as well as for the handling of our relations with foreign Powers. It certainly does something to supply the commercial world with trade statistics received through its Consuls, but it could do much more for the real advancement of industry if it were advised and guided in technical matters by scientific opinion. The collection of facts useful in the improvement of industrial methods and processes should form a very important part of the work carried on at our Consulates. To leave this valuable work to men sent out by traders, is to court defeat by the countries which recognise the value of attachés possessing technical and scientific knowledge. We agree that our Chambers of Commerce might adopt with advantage the forward policy of some of the French Chambers of Commerce, but, at the same time, we hold that the comparison of the Chambers of the two nations does not show British traders to extreme disadvantage as regards enterprise, whereas the work of the British Government in the same direction is not comparable with that of other nations. As in trade, so in science and education, individuals have done their share in the work of advancement; it is the Government which lags behind.

As an example of what private associations do to discover in what way industrial practices and processes on the continent differ from those in Great Britain, we may mention the delegation recently organised by the British Iron Trade Association for the purpose of inquiring into the conditions of competition in the iron and steel industries of the continent. The report of the delegates has just been finally adopted by the Association, and one or two points in it furnish instructive reading. It is admitted that both Belgium and Germany are well to the front in regard to mechanical appliances. The general arrangement of the blast furnace plants was modern and excellent, and they appeared to be worked to secure a large output with a minimum of capital and labour expenditure. In the finished iron and steel works visited, the practice adopted was excellent, and in some respects in advance of England. But of more especial interest to us is the fact that attention is called to the greater importance attached in Germany than in England to technical education, and the facilities given for its acquisition. This is regarded as one of the reasons why Germany has been able to quickly acquire, and make rapid advances in, iron and steel manufacture. On account of the attention given to scientific and technical education, the masters, as a rule, thoroughly understand the principles of their industrial processes, and are therefore able to economise in matters of detail; and moreover, they recognise the value of scientific advice and guidance upon all questions of improved methods.

THE appointment of Scientific Adviser to the Trinity House, which has been in abeyance since the resignation of Dr. Tyndall, and which was formerly held by Prof. Faraday, has been revived, and has been accepted by Lord Rayleigh.

THE engineer to the scheme for bringing sea-water from Lancing to London has prepared, for the information of Parliament, an estimate of the entire cost of this scheme. He states that the works contained in the Bill can be carried out for £450,000, which includes the acquisition of all the necessary lands for the distribution of sea-water throughout London.

A REUTER telegram from Christiania announces that Lieut. Ewind Astrup, the well-known Polar explorer, who took part in both Lieut. Peary's Greenland expeditions, was found dead on Tuesday in the Lille-Elvedal. Lieut. Astrup left Jerkin, at the foot of Sneehätta, in the Hovre Fjeld, shortly before Christmas, but since then nothing had been heard of him. A few days ago twenty-five men on snow-shoes started out to search for the explorer, with the result that they found his remains in the valley.

THE Committee of the Œuvre de la Tuberculose, founded by the late Prof. Verneuil, have (says the *British Medical Journal*) elected Prof. Bouchard to succeed that distinguished surgeon in the office of President. Prof. Lannelongue was at the same time elected Vice-President, and Dr. L. Henri Petit, General Secretary. The next Congress on Tuberculosis, which had been fixed for July 1896, has been postponed to 1897.

WE are informed that the Geological Society will this year award the following medals and funds:—The Wollaston medal to Prof. E. Suess, the Murchison medal to Mr. T. Mellard Reade, the Lyell medal to Mr. A. Smith Woodward, the proceeds of the Wollaston fund and part of the Barlow-Jameson fund to Mr. Alfred Harker, the proceeds of the Murchison fund to Mr. Philip Lake, the proceeds of the Lyell fund to Dr. W. F. Hume and Mr. W. C. Andrews, the proceeds of the Barlow-Jameson fund to Mr. Joseph Wright and Mr. John Storrie.

AN International Exhibition is to be held at Brussels in 1897. The exhibition will comprise fourteen sections: 1. Fine arts. 2. Social economy. 3. Hygiene. 4. Life saving. 5. Industrial and decorative arts. 6. Lighting and heating. 7. Electricity—traction. 8. Military art. 9. Industrial manufactures—materials, methods, and products. 10. Sporting material. 11. Exercises—popular games. 12. Temporary competitions in agriculture and horticulture. 13. Practical teaching, and the industries and handiwork of women. 14. Trade. Colonies.

A PRELIMINARY account of the Florentine earthquake of last May 18, the strongest felt in the district during the present century, has been written by Dr. M. Baratta. The chief damage

to buildings occurred within a nearly circular area about 35 km. in diameter, the centre of which is close to Florence. The disturbed area contains about 27,000 sq. km. Under the form of microseismic movements, the earthquake was recorded at several Italian observatories, and also at Grenoble (France), which is 460 km. from Florence, the mean velocity to the latter place being 1·75 km. per second.

ACCORDING to a Reuter telegram from Christiania, the estate of Hafslund, near the great waterfall known as the Sarpsfos, between there and Göteborg, has been acquired by a syndicate, consisting chiefly of German and American capitalists, for the sum of 800,000 kroner. The purchasers intend to form a large company with a capital of three to five million kroner, in order to utilise the water power of the falls for electrical power, and establishing aluminium works on the same principle as planned at the Falls of Foyers in Scotland. The Sarpsfos is one of the finest falls in south-eastern Norway, being 74 feet in height and 116 feet in width.

THE ancestral history of the horse, long familiar as a most striking instance of the possibility of tracing a pedigree by the aid of palæontology, is now being worked out still more minutely. In a paper just published (*Bull. Amer. Mus. Nat. Hist.*, December 23, 1895) on the Perissodactyls of the White River beds (Oligocene and Lower Miocene), Messrs. Osborn and Wortman announce the discovery of so complete a series of intermediate forms between *Mesohippus Bairdi* and *Anchitherium præstans*, that a strict definition of generic and specific names becomes impossible. These two and the intermediate types "form a closely-connected phylogenetic series of animals, slowly specialising and constantly increasing in size. So far as we know," the authors add, "there is not a single character missing in the structural chain."

AMONG the many points of interest which they possess, the Ratite birds of the southern hemisphere have presented no feature more curious and more inexplicable than the opercular fold which covers the transitory gill-slits in the neck of the embryo. The fold was first discovered five years ago by Prof. T. J. Parker, who described its occurrence in embryos of the New Zealand *Apteryx;* but its recent discovery by Prof. Nassonow in embryos of the ostrich also (*Zool. Anzeiger*, No. 492) shows that it is a feature which probably characterises the development of all the Ratite birds. A branchial operculum has not, however, been observed in the early stages either of reptiles or of Carinate birds, and the retention of so obviously amphibian a character in Ratite birds alone among Sauropsida provides a puzzle for ornithologists and embryologists alike.

IT is interesting to note, with reference to the observation of of the meteor seen at Cahirciveen on the 6th inst. (NATURE, p. 253), notice of which was sent to us by Mr. R. H. Scott, that according to a letter received at the Meteorological Office from Dr. A. Riggenbach, of Basle, a similar phenomenon was seen at Hochwald, about seven miles to the south of the former place, at 6 p.m. on the same evening. The observer noticed over the mountains of Nunningen what appeared to be a star of unusual magnitude. After looking at it for some time he was surprised to find it moving and leaving a long trail after it. The light increased in splendour, being first of a yellowish colour, which, upon the bursting of the meteor into three or four pieces, assumed a bluish-green colour. The movement continued in a south-westerly direction for about 1½ seconds, when the phenomenon disappeared below the horizon.

THE history of the introduction of the first hermetically-sealed thermometer into France is contained in *Cosmos* of the 4th inst., with extracts from the correspondence of Pierre des Noyers, Secretary of the Queen of Poland. In 1657 he sent a description of a Florentine thermometer to M. Boulliau, of Paris, with a drawing of it, which is reproduced in *Cosmos*, and in 1658 a specimen of the instrument was sent to Paris, and was apparently used by M. Boulliau on June 25 of that year. This thermometer was graduated by means of small black enamelled knobs on the outside of the tube, and was subsequently improved by the Accademia del Cimento. A full description of the instrument is contained in Prof. Hellmann's "Anfänge der meteorologischen Beobachtungen und Instrumente" in *Himmel und Erde*, vol. ii. p. 175 (see NATURE, vol. xlii. p. 207). We are indebted to M. G. Maze for the publication of extracts from the interesting original documents which are contained in the National Library in Paris.

AN account of some ingenious experiments on wind pressure is reported in *Engineering* of December 27 last, made by Messrs. H. C. Vogt and I. Irminger, of Copenhagen, to prove that "the greater part of the lifting power of an aeroplane, or the thrust of a close-hauled sail, was to be attributed to the rarefaction on the leeward side of the same, and not to the direct pressure." The experiments seem to show that even when a pressure-plate was perpendicular to the wind, the direct pressure was equal to only about one-third of the vacuum behind, and that when the vane was placed parallel to the wind, a negative pressure was indicated. For the purpose of the experiments, a current of air was produced by inserting in the side of a high chimney connected with the Gas Works one end of a rectangular conduit, the interior sectional area of which was $4\frac{1}{2} \times 9$ inches, and the length 40 inches. In this conduit was placed a hollow vane which reached from side to side, but the width of which was only $1\frac{5}{8}$ inches. The interior of the hollow vane was connected through its axis with a water-gauge, and the arrangement was such that the vane could be turned to any desired angle. Three holes were bored in both faces of the vane, but only one of these holes was used at a time, the others being stopped when not in use. We think that the results arrived at should be accepted with caution. The second leg of the pressure-gauge was connected with the inside of the conduit by an opening just above the vane, and there seems to be little doubt that the disturbance of the air current must, in such a small passage, have been considerable, and would probably affect the pressure upon the hole connected with the second leg of the gauge. This may possibly account for some of the rather improbable results obtained.

The Scalpel—a monthly journal of medicine and surgery—has just made its bow to a medical public. The new journal is edited by Dr. T. M. Dolan, and it will be conducted upon much the same lines as the late *Provincial Medical Journal.*

THE January *Journal* of the Sanitary Institute (vol xvi. part iv.) contains a paper on infectious diseases and methods of disinfection, by Dr. E. Seaton; and among the articles is one on the Hermite process for sanitation of towns, by Mr. E. J. Paterson.

THE careers of few men inspire such international admiration as the life of Huxley. His sterling qualities stand out so boldly that they command the attention of the entire intellectual world. The latest biographical notice that we have seen has appeared in the last two numbers of the *Revue Scientifique*, the author being Dr. H. de Varigny. We commend Dr. Varigny's appreciative notice to the attention of those who would be interested to learn of the high regard in which Huxley's works are held among men of science in France.

WE have received from Prof. G. Klebs, of Basel, an interesting paper entitled *Ueber einige Probleme der Physiologie der Fortpflanzung.* He deals with all the most recent observations on the phenomena of non-sexual propagation and of sexual reproduction, especially in the vegetable kingdom, and sums up

in favour of the view that the non-sexual was the original universal mode of multiplication. He supports this view largely by the phenomena of parthenogenesis, and by the fact that it is possible, by preventing the conjugation of the two gametes in *Spirogyra*, to cause each of them to develop into a "spore" fully capable of germination.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Miss Louisa Hutt: a Pig-tailed Monkey (*Macacus nemestrinus*, ♂) from Java, presented by Mr. W. Englehardt; a Puff Adder (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham: two Golden-crowned Conures (*Conurus aureus*) from South-east Brazil, deposited; two Black-headed Caiques (*Caica melanocephala*) from Guiana, a Green-cheeked Amazon (*Chrysotis viridigenalis*), from Columbia, purchased.

OUR ASTRONOMICAL COLUMN.

A NEW AUSTRALIAN OBSERVATORY.—The site for the new observatory, which the Government of West Australia are about to erect, has been selected at Perth. The cost of the buildings and instruments is estimated at about £5000. The latter will have such improvements on ordinary construction as have been suggested by experience with the instruments used at the Adelaide Observatory. The equipment will include an equatorial having an object-glass of 8 inches aperture. This instrument will be furnished with a spectroscope, and with photographic appliances. There will also be a transit circle 6 inches in diameter. The post of Astronomer has been filled by the appointment of Mr. W. Ernest Cooke, the Assistant Astronomer of South Australia. Mr. Cooke is an Australian by birth, and has been trained under Sir Charles Todd in observatory work.

THE SUN'S PATH IN SPACE.—The question as to a possible orbital movement of the solar system is revived by Mr. G. C. Bompas in the current number of the *Observatory*. Determinations of the position of the apex of the sun's way have been variously based on groupings of selected stars according to number, magnitude, or proper motion, the latter being now acknowledged the best test of distance. When arranged according to the distances of the stars on which they are based, the results seem to indicate that the position deduced from the nearer stars moves south-west along the plane of the Milky Way, as compared with the apex derived from stars supposed to be more distant. If the sun's path were rectilinear and the stars at rest, the "radiant point" would be the same for near and distant stars, but if curvilinear it would be shifted in accordance with the varying direction of the tangent, and the displacement would be in proportion to the apparent velocity. From existing data, Mr. Bompas considers it probable that the sun moves in a retrograde orbit from east to west in a plane inclined a few degrees to the Milky Way, and the conclusion is independent of any further consideration as to the presence or absence of a systematic movement of the stars round a common centre. "The relation of the solar system to the galaxy would thus resemble that of Uranus and his moons to the ecliptic, the solar system being inclined about 70° to the plane of the galaxy and the planets revolving round the sun in a reverse direction to the orbit attributed to the sun."

EQUATORIAL VELOCITY OF JUPITER.—A spectroscopic determination of the equatorial velocity of rotation of Jupiter has been made by Dr. Belopolsky, the resulting value being 11·4 kilometres per second (*Ast. Nach.* 3326). Taking the rotation period to be 9h. 50m., the calculated velocity varies from 12·1 to 12·8 kilometres per second, according to the angular diameter which is accepted. Although the difference between the observed and computed velocity is possibly within the limits of error in measurement, it is not considered improbable that the apparent discrepancy may have its origin in the increase of the angular diameter of the planet due to refraction in its atmosphere, and the consequent apparent increase of the calculated linear velocity. A similar result has been observed in the case of Saturn, the measured velocity being smaller than that which the known rotation period and angular diameter require.

PERRINE'S COMET.—The comet discovered by Mr. Perrine on November 16, 1895, was well observed in the northern hemisphere up to December 7, when it was seen at Greenwich, and stated to be very bright with a conspicuous tail. It was thought that it might possibly be subsequently observed in daylight in the southern hemisphere, but no observations have been published so far as we are aware. Towards the end of January it will be sufficiently removed from the sun to be seen as a morning comet, but with greatly diminished brightness. The following ephemeris, for Berlin midnight, is by Dr. E. Lamp:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
Jan. 24	19 37 27	−7 3·4	0·43
28	39 13	5 51·2	0·35
Feb. 1	40 50	4 41·6	0·29
5	42 17	3 33·7	0·25
9	43 34	2 27·0	0·21
13	44 40	1 21·0	0·18
17	45 33	−0 15·5	0·16
21	46 13	+0 49·8	0·15
25	46 38	1 55·1	0·13
29	46 48	+3 0·7	0·12

The unit of brightness is that on November 18.

OYSTERS AND TYPHOID.

THE fourth meeting of the tenth session of the Liverpool Biological Society was held on January 10, at University College, Liverpool. During the evening an interesting report on "Green Oysters, and the connection between Oysters and Disease" was presented by Prof. Herdman, who explained that a year ago he and Prof. Boyce commenced to investigate the conditions under which oysters lived healthily. Among other matters they directed their particular attention to the possibility of the oyster being infected by sewage in sea-water with the typhoid organism, and of so transmitting the disease to the consumer. At the meeting of the British Association at Ipswich, last September, they communicated the results they had obtained up to that point, and then they were appointed (with the addition of Prof. Sherrington and Mr. G. C. Bourne) as a committee to investigate the matter further. At present they were really in the midst of their observations; and the present communication could only be regarded in the nature of an interim report, as their conclusions would not be drawn up for publication until the meeting of the British Association in September next. In the meantime a most alarming and widespread scare, following upon incidents connected with a ball at Stirling, on October 1, had arisen, it being assumed that there was some connection between oysters and an outbreak of typhoid. This had considerably affected the important oyster trade of the country, and had probably thrown a great deal of quite undeserved suspicion upon perfectly wholesome oysters. Under these circumstances they had felt it their duty to take an early opportunity of stating their results and impressions as they stood at present. Their work, so far as it had gone, was of a reassuring character, and demanded from the public at the very least a suspension of judgment, whilst it indicated that the adoption of some simple sanitary precautions would, if properly carried into effect, go far to remove suspicion from the oyster. Prof. Herdman then proceeded to describe, with the aid of lantern slides, specimens and microscopic preparations, the different descriptions of oysters which are supplied in North-west Europe, and the methods of treatment they are subjected to prior to being placed on the market. He dealt with the cultivation of the French green oyster, and discussed the cause of the green colour, both in that oyster and in Americans relaid on the Lancashire coast. He pointed out that the most important precaution to take in oyster culture was to choose perfectly healthy grounds for the fattening process, it being necessary, in the first place, to ascertain that the purity from sewage of the water was beyond question. Further it was advisable to submit the oysters for a short time to disgorging basins or tanks, a method which was adopted with success by the French, before sending them to the market. Prof. Boyce then followed with an account of the experiments on the infection of oysters with typhoid, and showed, by means of tables, the rate at which the typhoid bacillus disappeared in sea-water. There was no evidence of increase in numbers of the bacillus when grown in sea-waters, either when incubated or at ordinary temperatures.

THE SMITHSONIAN INSTITUTION.[1]

II.

The System of Administration.

THE Smithsonian Institution was formally established by the Act of Congress approved August 10, 1846. As defined in the fundamental Act the "Establishment," a body which is in fact "the Institution," is composed of the President of the United States, who is presiding officer *ex officio*, the Vice-President, the Chief Justice, and the members of the Cabinet; and the body thus constituted is made responsible for the duty of "the increase and diffusion of knowledge among men."

In addition to the "Establishment," the Act provides for a "Board of Regents," by whom the business of the Institution is administered, composed of the Vice-President of the United States, the Chief Justice of the Supreme Courts, three members of the Senate, three members of the House of Representatives, and six citizens, no two of whom may be from the same State, though two must be residents of the District of Columbia.

The presiding officer of the Regents is the Chancellor, whom they may elect from their own number. This position has, however, customarily been held by the Vice-President or by the Chief Justice. The executive officer is the Secretary of the Institution, who is elected by the Regents, and is also the Secretary of that Board. The duties and responsibilities of the Secretary are, as has already been explained, such as in other institutions usually belong to the office of Director. He presents to the Regents an annual report upon the operations, expenditures, and condition of the establishment, which is transmitted by the Board to Congress for publication. By special Act of Congress of 1884 an acting-Secretary is provided, in case of the absence or disability of the Secretary, the designation being left with the Chancellor of the Institution. There is at present but one assistant-Secretary, who is in charge of the National Museum.

The annual meeting of the Regents is held in January; their executive committee of three members meet quarterly.

The building occupied by the Institution, and bearing its name, is an ornate structure of Seneca brown stone, occupying a prominent position in the "Mall," which extends from the Capitol to the Washington Monument, in the square known as the Smithsonian Park. This edifice, planned by James Renwick, was begun in 1847 and completed in 1855. Features from different periods of Romanesque styles are combined in its architecture; but its exterior, owing chiefly to the irregular skyline, is very picturesque and pleasing.

The eastern wing of the building, for so many years the hospitable home of Prof. Henry, has been reconstructed internally, and the offices of the Institution are all established within its walls. The remainder of the building is occupied by the laboratories and exhibition halls of the National Museum.

Another building of brick, 325 feet square, was built east of the Smithsonian in 1881, for the reception of a portion of the Museum collections.

The Objects of the Institution.

The objects of the Institution, as defined by Henry, are, first, to increase knowledge by original investigations and study either in science or literature; and, second, to diffuse knowledge, not only through the United States, but everywhere, especially by promoting an interchange of thought among those prominent in all nations. No restriction is made in favour of any one branch of knowledge.

The leading features of the plan of Prof. Henry were, in his own words, "to assist men of science in making original researches, to publish them in a series of volumes, and to give a copy of them to every first-class library on the face of the earth." There are not many scientific investigators in the United States to whom a helping hand has not at some time been extended by the Institution, and the hand has often reached across the Atlantic. Books, apparatus, and laboratory accommodation have been supplied to thousands, and each year a certain number of money grants have been made. Not less important has been the personal encouragement afforded, and the advice given in the tens of thousands of letters of information written in response to inquiries.

It is not, as some persons suppose, a teaching institution, nor does it receive students. It constantly aids, however, in the improvement of the educational system of the country.[1]

An important feature in the educational work of the Institution has been its participation in the various International Expositions. It was represented at Philadelphia in 1876; Berlin, 1880; London, 1883; New Orleans, 1885; Cincinnati, 1889; Madrid, 1892; Chicago, 1893; Atlanta, 1895; and has received many medals and diplomas of commendatory nature upon these occasions.

The Publications.

The publications are numerous, and include many important and authoritative works. There is no restriction as to subject, and they consist of memoirs upon archæology, ethnology, botany, zoology, geology, palæontology, meteorology, magnetics, physics, physiology, and philology, and many other branches of investigation.

These books are practically given away, for although there is a provision for their sale at cost price, only a few hundred dollars worth are sold each year. They are regularly distributed to about 4000 institutions in all parts of the world, and are supplied also to numerous private investigators. There are several series, the aspect of which must be familiar to every observing person who has ever spent a day among the shelves in any American library of respectable standing.

(1) The Annual Report of the Regents to Congress, of which the forty-ninth, that for 1894, is now in press. Since 1884 the report of the Museum has been printed in a separate volume (Part II.).[2]

(2) The Smithsonian Contributions to Knowledge, thirty-two volumes in quarto, containing over 7000 pages and many fine plates.[3]

(3) The Smithsonian Miscellaneous Collections, in thirty-five octavo volumes, aggregating about 22,000 pages.[4]

(4) The Bulletins of the National Museum, fifty in number, beginning in 1875.[5]

(5) The Proceedings of the National Museum, including already 1100 separate papers, embraced in seventeen annual volumes, beginning in 1878.[6]

(6) The Annual Reports of the Bureau of Ethnology, beginning in 1879, and forming a series of twelve illustrated volumes in royal octavo.[7]

(7) The Bulletin of the Bureau of Ethnology, of which twenty-six numbers have appeared.[8]

The value of the books distributed since the Institution was opened has been nearly 1,000,000 dollars, or nearly twice the original bequest of Smithson.[9] Many of the publications in each of these series are now out of print.

The Library.

One of the most important features of the Institution is the library which has grown up under its fostering care. For nearly fifty years its publications have been distributed throughout the world to almost every scientific and literary establishment of good repute. In return for these, and by purchase, it has received the great collection of books which forms its library, and which is one of the richest in the world in the publications of learned societies, and therefore of inestimable value, containing as it does the record of actual progress in all that pertains to the mental and physical development of the human family, and affording the means of tracing the history of every branch of

1 By Dr. G. Brown Goode. (Continued from page 261.)

1 The Institution supports a table at the International Zoological Station in Naples for the benefit of naturalists. There is an assembly hall in the Museum building, in which meetings of scientific bodies of national scope are held. Here the National Academy of Sciences holds its annual meeting every April, and the American Historical Association (which is by law affiliated with the Institution) its December meeting. Here also each year a course of popular scientific lectures is delivered under the direction of the scientific societies of Washington.

2 "Public Documents" printed by order of Congress, and distributed in large editions.

3 Published at the cost of the Smithsonian Fund, and not "Public Documents."

4 *Ibid.*

5 Published in a limited edition from a special appropriation, and not "Congressional Documents."

6 *Ibid.*

7 "Public Documents" printed by order of Congress, and distributed in large editions.

8 The Bureau also supervises a series of quarto volumes, bearing the title "Contributions to North American Ethnology," begun in 1877 by the U.S. Geographical and Geological Survey, of which nine have been issued.

9 This estimate is based upon the prices which are charged for the books by second-hand dealers, as shown in their sale catalogue.

positive science since the days of the revival of letters until the present time.

This library was, in 1865, deposited at the Capitol, as a portion of the Congressional Library.

The Smithsonian Collection, which includes more than three hundred thousand volumes and parts of volumes, constituting perhaps one-fourth of the National Library, is to be installed in a special stack-room of its own upon the main floor of the new Library Building, with a commodious reading-room adjacent for the use of special students. The rapidity with which it is increasing is indicated by the fact that in 1894, 37,952 titles were added.[1]

The Institution has probably done more towards building up a great library in Washington than would have been possible had all its income been devoted strictly to library work, as was at one time seriously proposed.

THE NATIONAL MUSEUM.

The Smithsonian Institution is the custodian of the National Museum, which is the only lawful place of deposit of "all objects of art and of foreign and curious research, and all objects of natural history, plants, and geological and mineralogical specimens, belonging to the United States." The nucleus of the collections consists of the specimens brought home by the Wilkes and other exploring expeditions, but for many years the Museum was supported entirely at the expense of the Smithson Fund, and a considerable portion of the collections is the property of the Institution. Since 1881, the entire expenses of administration have been met by Congressional appropriations. The appropriations from 1858 to 1880 were only sufficient to meet these expenses in part.

FIG. 6.—The New Museum Building.

Prof. Huxley defines a museum as "a consultative library of objects." The National Museum is such a consultative library, and it is a great deal more. It is an agency for the instruction of the people of the whole country, and it keeps in mind the needs of persons whose lives are not occupied in the study of science as well as those of the professional investigator and teacher.

Its benefits are extended without cost or reserve to hundreds of thousands of visitors from all parts of the United States who pass through its doors each year, as is shown in the following table:

Number of Visitors since 1881.

Year.	New Building.	Old Building.	Total.
1881	150,000 ...	100,000 ...	250,000
1882	167,455 ...	152,744 ...	320,199
1883	202,188 ...	104,823 ...	307,011
1884 (half-year)	97,661 ...	41,565 ...	139,226
1884-85 ...	*205,026 ...	102,093 ...	307,119
1885-86 ...	174,225 ...	88,960 ...	263,185
1886-87 ...	216,562 ...	98,552 ...	315,114
1887-88 ...	249,665 ...	102,863 ...	352,528
1888-89 ...	*374,843 ...	149,618 ...	524,461
1889-90 ...	274,324 ...	120,894 ...	395,218
1890-91 ...	286,426 ...	111,669 ...	398,095
1891-92 ...	269,825 ...	114,817 ...	384,642
1892-93 ...	*319,930 ...	174,188 ...	494,118
1893-94 ...	195,748 ...	103,910 ...	299,658
1894-95 ...	196,375 ...	109,847 ...	306,222
	3,380,253	1,676,543	5,056,796

* Years of Presidential inaugurations.

And also through the distribution of the duplicate specimens in the Museum, which are made up into sets, accurately named, and given to public institutions in all parts of the country.

The history of the Museum is divided into three periods: First, that from the foundation of the Smithsonian Institution to 1857, during which time specimens were collected purely and solely to serve as materials for research, no special effort having been made to publicly exhibit them or to utilise them, except as a foundation for scientific description and theory. Second, the period from 1857, when the Institution assumed the custody of the "National Cabinet of Curiosities," to 1876. During this period the Museum became a place of deposit for scientific material which had already been studied; this material, so far as practicable, being exhibited to the public, and thus made to serve an educational purpose. Third, the present period, beginning in the year 1876, during which the Museum has entered upon a career of active work in gathering collections and exhibiting them on account of their educational value.

During the first period, the main object of the Museum was scientific research; in the second, the establishment became a museum of record as well as of research; while in the third period there is growing up also the idea of public education.

The three ideas, *Record*, *Research* and *Education*, co-operative and mutually helpful as they are, are essential to the development of every great museum. The National Museum endeavours to promote them all.

It is a *Museum of Record*, in which are preserved the material foundations of an enormous amount of scientific knowledge—the types of numerous past investigations. This is especially the case with those materials that have served as a foundation for the reports upon the resources of the United States.

It is a *Museum of Research*, which aims to make its contents serve in the highest degree as a stimulus to inquiry and a foundation for scientific investigation. Research is necessary in order to identify and group the objects in the most philosophical and instructive relations, and its officers are therefore selected for their ability as investigators, as well as their trustworthiness as custodians.

It is an *Educational Museum*, through its policy of illustrating by specimens every kind of natural object and every manifestation of human thought and activity, of displaying descriptive labels adapted to the popular mind, and of distributing its publications and its named series of duplicates.

The collections are installed, in part, in the Smithsonian

[1] The working libraries of the National Museum and the Bureau of Ethnology are distinct from the general Smithsonian Library, and are separately administered. All of these are placed at the service of advanced students and specialists.

building and, in part, in the large building adjacent, covering three and a half acres of ground, which was erected in 1881 to afford temporary accommodation for the overflow until such time as an adequate new building could be constructed.

The number of specimens in the various departments of the Museum, in 1894, is shown in the following table:

STATISTICS OF THE NATIONAL COLLECTIONS.

Arts and Industries.	
Historical collections, coins, medals, &c.	29,998
Musical instruments	1,219
Modern pottery, porcelain, bronzes, &c.	3,583
Graphic arts	1,704
Physical apparatus	366
Transportation and engineering	1,793
Naval architecture	802
Fisheries	10,080
Animal products	3,028
Domestic animals	162
Chemical products	1,309
Materia medica	6,317
Foods	1,111
Textiles	3,306
Forestry	726
Ethnology	423,000
Oriental antiquities and religious ceremonial	4,145
Prehistoric anthropology	153,424
American aboriginal pottery	33,293
Mammals	12,948
Birds	73,325
Birds' eggs and nests	58,041
Reptiles and batrachians	34,215
Fishes	125,000
Vertebrate fossils[1]	1,595
Mollusks (including Cenozoic fossils)	510,256
Insects	610,000
Marine invertebrates	520,000
Comparative anatomy	14,828
Palæozoic fossils	95,631
Mesozoic fossils	89,493
Fossil plants	113,685
Recent plants	252,111
Minerals	25,431
Geology	63,606
Total	3,279,531

The importance of these collections is greatly enhanced by this fact, that they include many thousands of types of the original descriptions of the pioneers of American natural history—Audubon, Baird, Agassiz, Girard, Cope, Marsh, Gray, Young, Dana, Gill, Jordan, and many more, and as such constitutes an important part of the foundation of our systematic zoology and botany.

The intrinsic value of such material as this cannot well be expressed in figures. There are single specimens worth hundreds, others worth thousands of dollars, and still others which are unique and priceless. Many series of specimens, which owe their value to their completeness and to the labour which has been expended on them, are priceless. The collections at a forced sale would realise more than has been expended on them, and a fair appraisal of their value would amount to several millions of dollars.

In the direct purchase of specimens but little money has been spent, less perhaps in fifty years than either France, England, Germany, or Austria expends in a single year on similar objects. The entire Museum is the outgrowth of Government expeditions and expositions, and of the gifts prompted by the generosity of the American people.

THE BUREAU OF EXCHANGES.

The Smithsonian system of international exchanges, begun in 1852, had for its object the free interchange of scientific material between scientific institutions and investigators in the United States and those in foreign lands. For this purpose it established correspondence with scientific societies, literary and learned men all over the world, until there is no civilised country or people, however remote, upon the surface of the planet, so far as is known, where the Institution is not represented. The list of correspondents has lengthened until those external to the country alone number nearly 17,000, while the total number is about 24,000.

Many of the principal steamship companies gave generous aid in recognition of this disinterested work by granting important concessions of free freight. The United States and foreign Governments permitted the entrance through their Customs services of Smithsonian exchange boxes, and the Institution was enabled to distribute its exchange packages in this country, without expense to its funds, under the franking privilege.

In recent years the Smithsonian has been recognised by the United States Government as being in charge of its official Exchange Bureau, through which the publications of Congress are exchanged for those of foreign Governments, and by a formal treaty it acts in an official capacity as intermediary between the learned bodies and literary and scientific societies, &c., of the contracting States for the reception and transmission of their publications.

The Exchange Service has become a most valuable adjunct to educational interests, and there are few important libraries or workers in science, either at home or abroad, who have not had direct experience of its benefits.

The rules established for its control provide for the distribution to any accessible point abroad of books, pamphlets, charts, and other printed matter sent as *donations or exchanges*, and without expense to the sender beyond that of the delivery of the packages to the Smithsonian Institution in Washington, and also without expense to the receiver, except in some instances the small cost of delivery from the Smithsonian agent or correspondent nearest at hand. Similar material sent from abroad to this country is forwarded to the recipient without expense to him, the packages having been delivered free of freight charges to a foreign agent or correspondent of the Institution.

A scientific society or individual in the United States desiring to take advantage of the Exchange Service should have each of the packages transmitted strongly wrapped and separately and legibly addressed, being careful to give the full local address, and should send them in bulk, carriage prepaid, to the Institution in Washington. The separate packages should not exceed one-half of one cubic foot in bulk, and they should not contain letters or written matter.

Transmissions from abroad are received by freight in large boxes, and are distributed in the United States under frank by registered mail, a record first having been made of the name of the sender and of the address of each package. A receipt card, returnable by mail without postage, is sent with each of these packages, and should be forwarded at once by the recipient in acknowledgment of the package.

The Institution and its agents will not knowingly receive for any address purchased books, nor apparatus and instruments, philosophical, medical, &c. (including microscopes), whether purchased or presented; nor specimens of natural history, except where special permission from the Institution has been obtained.

The operations of this Bureau have affected most beneficially the libraries of all learned institutions in America. In 1867 Congress assigned to the Institution the duty of exchanging fifty copies of all public documents for similar works published in foreign countries. Finally in 1889 a definite treaty, made previously at Brussels, was formally proclaimed by the President of the United States, wherein the United States Government, with a number of others, undertook the continuation of the exchange service on a more extensive basis. Out of this has grown the Bureau of International Exchanges, for the maintenance of which Congress partially provides by annual appropriation. From 1852 to 1895 the Smithsonian exchange service handled 1,459,448 packages, and for three years past the weight of books passing through this office has been considerably over one hundred tons annually.

SPECIAL GIFTS AND TRUSTS.

The authority of the Institution to undertake the administration of financial trusts for any purpose within the scope of its general plan, preserving in connection with each fund the name of the person by whom it was established, has been recognised by Congress.

There is no institution in the world which is more favourably

[1] Only that portion of the Collection which is in Washington is included.

situated for the administration of trusts of this character, and this privilege has, within the past few years, been accepted by several benefactors.

Dr. Jerome H. Kidder, of Washington City, bequeathed, in 1889, 5000 dols. for the purpose of an astro-physical observatory.

Dr. Alexander Graham Bell, in 1889, gave 5000 dols. to the Secretary for his personal use in physical investigation, which has been transferred by him to the credit of the Institution, and devoted to physical work.

Mr. Thomas G. Hodgkins, of Setauket, N.Y., gave, in 1891, nearly 250,000 dols., a portion of the income from which is to be applied to the investigation of atmospheric air.[1]

Robert Stanton Avery, of Washington City, who died in 1894, left property then estimated to be worth at least 50,000 dols. to provide for special investigations.

There have also been many valuable gifts to the Museum, such as that of Dr. Isaac Lea, of Philadelphia, who gave his great collections of mollusks, and of gems and precious stones; that of Mr. Joseph Harrison, of Philadelphia, consisting of the collection of Indian portraits painted by George Catlin; that of Mr. R. D. Lacoe, of Pittston, Pa., the largest existing collection of American fossil plants; and the collections of American birds' eggs given by Major Charles Bendire, U.S.A., and Dr. William H. Ralph, of Utica, N.Y.

THE ASTRO-PHYSICAL OBSERVATORY.

The Astro-physical Observatory was established in 1891, under the immediate direction of the present Secretary. The expense of maintenance has since been provided for by a small appropriation from Congress. Here is carried on work corresponding to that of similar institutions maintained by the principal European Governments, and on a much less expensive scale, though not less effectively.

Since astro-physics is almost the newest of sciences, it may not be amiss to give here a brief description of the purposes of this observatory:

"Within the past generation," we are told, "and almost coincidentally with the discovery of the spectroscope, a new branch of astronomy has arisen, which is sometimes called astro-physics, and whose purpose is distinctly different from that of finding the places of the stars, or the moon, or the sun; which is the principal end in view at such an observatory as that, for instance, at Greenwich.

"The distinct object of astro-physics is, in the case of the sun, for example, not to mark its exact place in the sky, but to find out how it affects the earth and the wants of man on it; how its heat is distributed, and how it in fact affects not only the seasons and the farmer's crops, but the whole system of living things on the earth, for it has lately been proven that in a physical sense it, and almost it alone, literally first creates and then modifies them in almost every possible way.

"We have, however, arrived at a knowledge that it does so, without yet knowing in most cases how it does so, and we are sure of the great importance of this last acquisition, while still largely in ignorance how to obtain it. We are, for example, sure that the latter knowledge would form, among other things, a scientific basis for meteorology, and enable us to predict the years of good or bad harvests, so far as these depend on natural causes, independent of man, and yet we are still very far from being able to make such a prediction, and we cannot do so till we have learned more by such studies as those in question. Knowledge of the nature of the certain, but still imperfectly understood dependence of terrestrial events on solar causes is, then, of the greatest practical consequence.

"It has been observed that this recent science itself was almost coeval with the discovery of the spectroscope, and that instrument has everywhere been largely employed in most of its work. Of the heat which the sun sends, however, and which, in its terrestrial manifestations, is the principal object of our study, it has long been well known that the ordinary spectroscope could recognise only about one-quarter, three-quarters of all this solar heat being in a form which the ordinary spectroscope cannot see nor analyse, lying as it does in the, till lately, almost unknown 'infra-red' end of the spectrum, where neither the eye nor the photograph can examine it."

This Observatory in Washington has been continuing the famous researches in regard to that invisible portion of the solar spectrum which lies beyond the limit of the red, which had been begun by Mr. Langley while director of the Allegheny Observatory. The exploration of "this great unknown region," which was first rendered possible by the invention of the bolometer, is now being carried still further by means of a new method, much perfected during the last four years, which has rendered it possible to produce a complete map by an automatic and absolutely trustworthy process, which shows the lines which resemble the so-called Fraunhofer lines in the upper spectrum. The results already attained are believed to be the most important which have ever been reached in regard to that region of the spectrum of which so little is known, and which includes the greater portion of all those energies of the sun which, through its heat, affect climate and the crops, and are thus related not only to questions of abstract interest, but to utilities of national importance.

THE NATIONAL ZOOLOGICAL PARK.

The National Zoological Park was established by Congress in 1890, as a result of the desire to secure the preservation of such American animals as are upon the verge of extinction and will soon vanish for ever if something is not done to protect them, and occupies a tract nearly twice as extensive as that of any zoological garden in the world; this includes one hundred and sixty-seven acres upon Rock Creek, only two miles north of the Executive Mansion, at the centre of the city. The site has admirable natural advantages, and much has already been done in the opening of drives and the construction of buildings.

When Congress was asked to appropriate funds for this Park, it was in view of the fact that many North American animals, constituting a part of the national wealth, and formerly occupying a large portion of its domain, are threatened with speedy extinction.

The buffalo, the beaver, the wapiti, the moose, and many other species, which until lately were abundant east of the Mississippi, are each year becoming rarer. On the Pacific Coast the sea-elephant is gone, and the walrus practically so, and the sea-otter, the fur-seal, and the sea-lion rapidly disappearing. The passenger-pigeon and the Carolina parrakeet are almost gone. It was urged upon Congress that unless steps were speedily taken, these races must perish.

The reservation of the Yellowstone National Park as a great game preserve was an important start in this direction, but the very immensity of the reservation seems to threaten the defeat of the plan, for the animals cannot be protected from marauders, and are being rapidly destroyed. To retard their extinction and to provide opportunities for their study, was the intention of those who first advocated the establishment of a preserve near Washington large enough to keep the animals as close to natural conditions as is possible, and the project seems to have been even more important than was at first supposed.

A small representative collection of native American animals has already been formed, including about five hundred individuals, among them a fine herd of young elk and a small herd of buffaloes; but the annual appropriations have not been sufficient to permit satisfactory progress.

THE BUREAU OF AMERICAN ETHNOLOGY.

The Bureau of Ethnology is an outgrowth of activities beginning early in the history of the Institution, which has from the very outset devoted much attention to the native American races.

The special work of the Bureau in its present form was begun in 1872, in response to a request from the Commissioner of Indian Affairs, who desired trustworthy information concerning the affinities of the Indian tribes, to serve as a guide in grouping them on the reservations. The question was referred by the Secretary of the Smithsonian Institution to Major J. W. Powell, then engaged, under the direction of the Institution, in explorations in the south-west. Combining the vocabularies and other manuscipts already in possession of the Institution, he prepared a report showing the character and extent of existing information, and the manner in which it was possible to utilise this in the segregation of the Indian tribes, at the same time suggesting plans for the completion of the work of classification.

This was the beginning of the Bureau, which since 1879 has been supported by special appropriations from Congress, with the understanding that the research should be so extended as to

[1] A prize of 10,000 dols., derived from this fund, was awarded August 6, 1895, to Lord Rayleigh and Prof. William Ramsay, of London, for the discovery of Argon, a hitherto unknown element in the atmosphere.

embrace the habits and customs of the American Indians, their tribal organisations and government, and their myths and ceremonials.

Major Powell was made director, and no one could have been better fitted for the task. For more than thirty years he had been a student of the native races of this continent. He and his associates in the Bureau have succeeded in placing on record, before it was too late, a vast number of facts in regard to the Indians. The Annual Reports of the Bureau, twelve in number, and nine volumes of Contributions to North American Ethnology, with the Bulletin of the Bureau, form a considerable library in themselves. The archives still contain much unpublished material, including hundreds of vocabularies.

A complete linguistic classification of the native languages of the United States has been prepared by the director, and an effective classification of the tribes on the reservation, reducing materially the danger of warlike outbreaks, has already been accomplished.

EXPLORATIONS.

The promotion of exploration has, from the beginning, been an important feature in the work of the Institution, and grants of money and loans of apparatus have been made to many hundreds of explorers, who have thus been enabled to contribute to the knowledge of the zoology, botany and ethnology of the American continent. Much has also been done in supplying scientific apparatus to the officers of the various Government surveys, which, in early days, were very often equipped only for geographical work. The Naval Astronomical Expedition to Chili was supplied by the Institution with a telescope and other apparatus, which was afterwards bought by the Government of Chili for the National Observatory at Santiago. The medical officers of the numerous surveys preliminary to the building of the transcontinental railroads, and those of the several boundary surveys, thus equipped for natural history work, made vast collections.

Members of the Smithsonian staff have frequently been detailed to serve as tidal or meteorological observers, under other departments of the Government, in remote localities, for the purposes of exploration. The important early explorations of John Xantus on the extremity of the Lower Californian Peninsula, and of Turner, Nelson, Murdoch, Kumlien, and others in the Arctic regions, were effected in this manner, as well as the earlier and more important work of Kennicott, Dall and Bannister, in Alaska, in connection with the Russian Telegraph Expedition.

On the staff of the Bureau of Ethnology important explorations of the western portion of the continent have been made, especially those of the Stevensons, Cushing, Fewkes, and the Mindeliffs, among the Pueblo people and the ruins of the southwest: those of Holmes among the prehistoric quarry sites and villages of the eastern part of the continent; those of Thomas among the mounds of the Mississippi Valley, and of McGee among the Papago and Seri Indians of the Mexican boundary; and the notable explorations of Major J. W. Powell among the tribes of Utah, California, Arizona and New Mexico.

The expeditions of Rockhill in Tibet, of Jouy in Korea, of Abbot and Chanler in Eastern Africa and Kashmir, Madagascar and the islands of the Indian Ocean, have been indirectly under the auspices of the Institution, and allusion should also be made to the visit of Major Dutton to the Hawaiian Islands for the study of volcanic phenomena, which was carried on directly at the expense of the Smithsonian Fund.

The Institution participated also in fitting out the Arctic Expedition of Kane, Hayes and Hall.

THE PROMISE OF THE FUTURE.

At the time of the Smithson bequest, the endowment of research had scarcely been attempted in America. There were schools and colleges in which science was taught, and certain of the teachers employed in these institutions were engaged in original investigation. There were a few young and struggling scientific societies, very limited in extent and influence, but at that time the chief outcome of American scientific work. Science in America was an infant in swaddling clothes. Fifty years have passed, and American science now stands by the side of the science of Great Britain, of Germany, of France, a fellow worker competing in nearly every field of research.

The Smithsonian Institution did what was, at the time of its organisation, absolutely indispensable to the rapid and symmetrical development of American scientific institutions, and but for it, science in America would no doubt have advanced with much less rapidity. It is also certain that the progress of American science has had an immense influence upon the welfare of America in every department of intellectual and industrial activity, and also a reflex action upon the scientific and industrial progress of the entire world.

This year the Smithsonian Institution will celebrate the end of its first half-century. A special volume will be published to commemorate the event, and two memorial tablets will be erected in honour of the founder in the city of Genoa, where he died, June 26, 1829; one in the English church, and one upon his tomb in the beautiful little English cemetery on the cypress-clad heights of San Benigno.

It is interesting to remember that in September next will occur not only the semi-centenary anniversary of the birth of the Institution founded in the City of Washington by Smithson, but also the centenary of the delivery of that immortal address in which Washington so forcibly recommended to his countrymen "to promote as an object of the highest importance INSTITUTIONS FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Council of the Royal Geographical Society offer in the present academical year a Studentship of £100, to be used in the geographical investigation (physical or historical) of some district approved by the Council. Candidates must be members of the University of not more than eight years' standing from matriculation, who have attended the courses of lectures given in Cambridge by the University Lecturer in Geography. Applications should be addressed to the Vice-Chancellor not later than the last day of the full Lent Term, March 13, 1896.

LORD HALSBURY has been elected Chairman of the Council of the City and Guilds of London Institution for the Advancement of Technical Education.

THE *Technical World* has extended its sphere of usefulness. Henceforth it will be the newspaper for secondary and technical education broadly defined. It has been accepted as the official organ of the Association of Headmasters, and of the Association of Organising Secretaries and Directors. The general policy of our contemporary will be to support the conclusions of the Royal Commission on Secondary Education, by which we understand that it will exert its influence in co-ordinating the work of secondary education. With one paragraph in the announcement of the enlargement of the journal we are in entire agreement; it is this: "That the organising secretaries and directors should have an official organ will serve to remind them (a fact which a few are prone to forget) that they have duties not only to their own counties and committees, but to each other and to higher education generally. The more they co-operate, and within limits agree, the better will be the individual work of each."

WISE words were spoken by Sir Henry Fowler last week, while commenting upon the report of the Wolverhampton Chamber of Commerce. Referring to the necessity for technical education, he remarked: "In this respect foreigners are ahead of England, and Chambers of Commerce might attach more importance to the point. In foreign countries they make greater sacrifices for it and do not grumble at the expense. In England we are now waking up to the importance of it, but we want technical education on a very much larger scale than we have as yet got it. We want it very much on the lines which the Committee of the Chamber of Commerce in their report point out, namely, technical instruction for foremen and better-class artisans. In a competition between two manufacturing countries, the country where the manufacturing population has the better technical education is more favourably placed in connection with its operations, and has a distinct advantage in the markets of the world." We are doing a little, it is true, to advance technical and scientific knowledge, but much of the money allocated to local authorities for technical education is being frittered away. Many Technical Instruction Committees are incapable of organising a scheme of instruction which will prove of permanent benefit to industry. Instead of concentrating their attention upon a few subjects, and supplying effective education in them, they devote £10 or £20 to each of a multiplicity

of little efforts. We find that technical education has been made to include all sorts of subjects, even music. Several Councils give grants to classes formed for the exclusive study of music, either instrumental or vocal. The following selection of subjects taught will give some idea of the variegated nature of "technical" work: farriery, straw-plaiting, basket-making, ploughing, draining and dyking, clicking, cabinet-making, thatching, sheep-shearing, fishing, sail-making, china-painting, hat-manufacture, type-writing, political economy, life-saving, and house-decoration. So long as such subjects absorb the attention of Committees, little national advancement is possible. Instruction in the dodges of the workshop may produce a more dexterous and quicker workman, but it does nothing to educate him in those broad principles which enable him to assist intelligently in the real improvement of industry.

THE spirit of rivalry which regulates the conduct of educational institutions in some of our large towns is to be deplored, for its effects are detrimental to the advance of education. Reports, received from time to time, show that, in many districts, local institutions compete with one another instead of forming distinct steps in the educational ladder. So common is this kind of competition that it is refreshing to learn that the City Council and the School Board of Manchester have agreed between themselves that the Technical School shall discontinue its more elementary classes, and begin its curriculum at the points where the Board schools leave off. An effort is to be made to secure a corresponding gradation between the Technical School and Owens College. Manchester has thus taken important steps towards the solution of a difficult problem in public education, and it would be well if those provincial towns that have not already considered the correlation of their technical and scientific institutions would do so without delay. It is a question, indeed, whether a central authority ought not to be able to give a definite place in the educational ladder to the various institutions in a town, and to insist upon the absence of competition with one another. With each part of the engine doing its proper work, progress will be made; but if there is a confusion of functions, advance is impossible. The establishment, in recent years, of numerous technical institutions in many of our large provincial towns, and the extension of the work of old-established Mechanics' Institutes and Trade Schools, make it very necessary that something should be done to define the place of these institutions in our educational system. The University Colleges are especially affected by such institutions. Bristol, for instance, possesses one of the best University Colleges in the country; it has done excellent work, and will certainly do more. But during the past few years the Merchant Venturers' School has largely developed, and it is now a rival establishment situated only a few hundred yards from University College, with which it competes. This competition is no doubt responsible, to some extent, for the adverse balance of £950 in the accounts of University College, Bristol, for the year 1895; the total indebtedness of the College is now more than £6000. There is ample room for both institutions in Bristol, but the work of one should supplement, and not clash with, the work of the other. What is happening in Bristol is happening elsewhere, and is retarding educational advancement. In fact, we have no hesitation in saying that one of the most important points which needs to be settled at the present time is that which refers to the status of various institutions in the scheme of education.

SCIENTIFIC SERIALS.

American Journal of Science, January.—The quarries in the lava beds at Meriden, Conn., by W. M. Davies. The present condition of the quarries in the Triassic (Newark) formation near Meriden shows the vesicular upper surface of one lava bed under the dense basal portion of a later flow, and a number of fractures dislocating the double flow.—The form of isolated submarine peaks, by G. W. Littlehales. Theoretically the form of an isolated submarine peak would be that of a solid of revolution in which the crushing strength of any section is equal to the combined weight of the portion of the formation above that section and of the superincumbent body of water. The author derives a general equation for the slope of submarine peaks, and finds that the average slopes of Dacia Bank, Seine Bank, The Salvages, and Enderbury Island are fairly in accordance with the formula. This investigation has an important bearing upon the intervals at which deep-sea soundings should be taken in searching for probable shoals in the open ocean and in developing the character of the sea-bottom. The minimum radius at the bottom which a dangerous shoal can have, must vary directly with the depth, but on the average, in the deep sea, it may be stated as ten miles. An interval of ten miles, coupled with an interval of two miles, would be sufficient for general development, and would prove with certainty the existence or absence of any formation rising close to the surface.—On the epidote from Huntingdon, Mass., and the optical properties of epidote. This epidote is almost identical with that of Zillerthal, in Tyrol, but has the lowest percentage of iron oxides (6·2) and the lowest double refraction of any epidote recorded.—The iodometric determination of selenious and selenic acids, by F. A. Gooch and A. W. Peirce. The principle previously applied to the estimation of chlorates is equally advantageous for the determination of selenious and selenic acids. The selenious acid is treated with potassium iodide, di-hydrogen potassium arseniate, and half-strength sulphuric acid. The liquid is concentrated by boiling, the residue is cooled and the acid nearly neutralised with potassium hydroxide, acid potassium carbonate is added in excess of neutralisation, and, after the addition of starch, standard iodide is introduced until the starch-blue appears. The iodine introduced measures the arsenious acid, and the difference between it and the iodine, originally present in the form of the iodide, represents the amount set free by the selenious acid. Selenic acid, on the other hand, may be determined iodometrically with accuracy by first reducing it to the condition of selenious acid by treatment with potassium bromide in the presence of sulphuric acid, and then completing the reduction to the elementary condition by the treatment with potassium iodide and potassium arseniate.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, December 18, 1895.—Dr. Henry Woodward, F.R.S., President, in the Chair.—Prof. G. K. Gilbert, Washington, D.C., was elected a Foreign Member, and Dr. A. Penck, Vienna, was elected a Foreign Correspondent of the Society.—The tertiary basalt-plateaux of North-western Europe, by Sir Archibald Geikie, F.R.S. The author in this paper gave the results obtained by him in the continued study of Tertiary volcanic geology during the seven years which have elapsed since the publication of his memoir on "The History of Volcanic Action during the Tertiary Period in the British Isles." His researches have embraced the Western Islands of Scotland, St. Kilda, and the Faröe Islands. In an account of the rocks of the basalt-plateaux, attention was particularly directed in this paper to a type of banded basic lavas which played an important part in the structure of the volcanic districts both of the Inner Hebrides and of the Faröes. A number of examples were adduced of the volcanic vents which form a characteristic feature of the basalt-plateaux. The paper described in some detail the evidence for the flow of a large river across the lava-fields during the time when volcanic activity was still vigorous. Many additional details were given to illustrate the structure and behaviour of the basic sills which are so abundantly developed, especially at the base of the plateaux. The author added some additional particulars, more especially from Skye and St. Kilda, to his published account of the dykes which had taken so important a place in the origin and structure of the plateaux. Further observations were narrated regarding the great bosses of gabbro in the Inner Hebrides. The author, having been able to visit St. Kilda, described the junction of the granophyre of that remote island with the basalts and gabbros. He brought away a series of specimens and photographs which demonstrated that the acid rock had been injected into the basic masses, traversing them in veins and enclosing angular pieces of them. The granophyre was precisely like that of Skye and Mull, and was traversed by veins of finer material, as in these islands. By way of illustrating the probable history of the basaltic plateaux of North-western Europe, the author gave a short summary of the results of recent investigations of the modern volcanic eruptions of Iceland, especially of Th. Thoroddsen and A. Helland. Reference was made to the evidence of considerable terrestrial movement since the Tertiary volcanic period, as shown by the tilting of large sections of the plateaux in different directions, and also by the existence of actual faults. The con-

cluding section of the paper dealt with the effects of denudation on the plateaux. The author remarked that there was certainly no other area in Europe where the study of the combined influence of atmospheric and marine denudation could be so admirably prosecuted, and where the imagination, kindled to enthusiasm by the contemplation of such scenery, could be so constantly and imperiously controlled by the accurate observation of ascertainable fact.—The British Silurian species of *Acidaspis*, by Mr. Philip Lake. Descriptions were given of those species of *Acidaspis* in the Silurian of Britain which have hitherto been incompletely described. The British forms were compared with those from the same system in Sweden and Bohemia. Five, out of nine, were represented by the same or very closely allied species in Sweden; two in Bohemia. All the Swedish forms except one were represented in Britain, and one in Bohemia as well as in Britain.

Royal Microscopical Society, December 18, 1895.—Mr. A. D. Michael, President, in the chair.—Mr. E. M. Nelson exhibited and described a portable microscope in which the stage had been enlarged to $4\frac{1}{2}'' \times 5''$, and the body fitted with three draw-tubes giving a range of length from $4\frac{3}{4}''$ to $12\frac{3}{4}''$.—A discussion on tube-length ensued, in which Mr. C. Beck, Mr. Nelson, and Mr. J. E. Ingpen took part.—Dr. H. C. Sorby gave an interesting account of his methods for preserving some of the more delicate marine organisms.—Mr. T. D. Ersser exhibited a new method for showing the multiplied images formed by the compound eyes of insects.—The President having reminded the Fellows that the meeting on January 15 would be their annual meeting, the list of Fellows recommended as officers and Council for the ensuing year was then read.

Mathematical Society, January 9.—Major Macmahon, R.A., F.R.S., President, in the chair.—Prof. Elliott, F.R.S., by a method used in connection with seminvariants, showed how to obtain a criterion as to whether or not a rational integral homogeneous function of y, a function of x, and its derivatives, is an exact differential, and further showed that if it is its integral can be found by differential operations only.—The President announced the title of a paper by Prof. Tanner, viz. on a certain ternary cubic. The paper, in the absence of the author, was taken as read. The notes chiefly relate to the automorphs and units of the form, and include a short geometrical discussion.—Mr. S. H. Burbury, F.R.S., made a further communication on Boltzmann's minimum function. Lieut.-Colonel Cunningham, R.E., and Dr. Larmor, F.R.S., joined in a discussion on the paper.—Mr. Love, F.R.S. (Hon. Sec.), communicated some examples illustrating Lord Rayleigh's theory of the stability and instability of certain fluid motions, and subsequently answered questions, bearing on the subject, by Dr. Larmor.

Entomological Society, January 15.—The sixty-third annual meeting, Prof. Raphael Meldola, F.R.S., President, in the chair.—After the balance-sheet had been read by one of the auditors, Mr. Goss read the report of the Council. It was announced that the following gentlemen had been elected as officers and Council for 1896: President, Prof. R. Meldola, F.R.S.; Treasurer, Mr. Robert McLachlan, F.R.S.; Secretaries, Mr. Herbert Goss and the Rev. Canon Fowler; Librarian, Mr. Geo. C. Champion; and as other members of the Council, Mr. Walter F. H. Blandford, Mr. Geo. F. Hampson, Prof. Edwd. B. Poulton, F.R.S., Mr. Osbert Salvin, F.R.S., Dr. D. Sharp, F.R.S., Mr. Roland Trimen, F.R.S., the Lord Walsingham, F.R.S., and Colonel J. W. Yerbury, R.A. It was announced that the President would appoint Dr. D. Sharp, Mr. Roland Trimen, and Mr. W. F. H. Blandford Vice-Presidents for the Session 1896–1897.—Prof. Meldola then delivered an address, in which he first drew attention to the remarkable literary activity of the entomologists of this country during the past year, referring particularly to the works recently published by Miall, Meyrick, Barrett, Rye, Lucas and Buckton, and to the new volume of the "Cambridge Natural History" by Sedgwick, Sinclair and Sharp. Attention was also called to the interesting discoveries in insect physiology by Latter and Hopkins. The main portion of the address was devoted to a plea for a more liberal use in biological work of the theoretical or speculative method which had proved so fruitful in other branches, and which, in the President's opinion, might with advantage be more freely employed in connection with entomological investigation. Illustrations were taken from the work of Bates on mimicry, Wallace on the colours of insects, and Poulton's researches on variable colouring, all of which had been prompted by hypothesis, and which had led to discoveries of large bodies of facts which would never have been gleaned by haphazard observation. In conclusion, the President referred to the losses by death during 1895 of many Fellows of the Society and other entomologists, special mention being made of Prof. Charles V. Riley, Prof. C. C. Babington, F.R.S., the Right Hon. T. H. Huxley, F.R.S., M. E. L. Ragonot, Major J. N. Still, Prof. Carl E. A. Gerstäcker, M.D., M. Claudius Rey, M. Jules F. Fallou, and Mr. W. H. Tugwell.

Royal Meteorological Society, January 15.—Annual meeting.—Mr. R. Inwards, President, in the chair.—The report of the Council showed that the Society was in a satisfactory condition, thirty-four new Fellows having been elected during the year. Mr. Inwards devoted his presidential address to the subject of meteorological observatories, which he illustrated with numerous lantern slides. After describing some ancient observatories, including the Nilometers and the Tower of the Winds at Athens, he gave an account of national observatories, of which the Royal Observatory, Greenwich, was taken as a type. High-level observatories were next described, of which that on Mont Blanc was taken as a type. Special reference was also made to the observatories on the Sonnblick, the high-level observatory at Arequipa on the Andes, and that on Ben Nevis. An account was next given of tower observatories, together with some of the results obtained from the Eiffel Tower at Paris. Mr. Inwards, in concluding, said: "One can figure to oneself a tower piercing the air from any of the elevated tablelands of this country—Salisbury Plain, the Stray at Harrogate, or the Downs between Guildford and Dorking—and from which the most interesting results could not fail to accrue. It is the opinion of M. Vallot—no mean authority—that a high tower is for air-observing purposes equivalent to a mountain station of ten times the altitude: and this is plain when one considers that any mountain must act as an obstacle which thrusts upward the strata of the atmosphere into a form almost like its own, so that some of the effects are very little different from those observed below; while a tower like the Eiffel Tower thrusts itself in the air without obstructing its movements. It is the boast of the Royal Meteorological Society that it is gradually covering the country with a network of private observing stations, and is collecting together, for the enlightenment of all future time, a mass of accurate knowledge on the subject of the changes in our atmosphere, its varying moods, its beating pulses, its calms and its convulsions, so that when the philosopher is born who is destined to unravel all its mysteries, he will have the tools and instruments ready to his hand."—Mr. E. Mawley was elected President for the ensuing year.

EDINBURGH.

Royal Society, December 2, 1895.—Prof. Geikie in the chair.—Before business proper was commenced, the Chairman, in reviewing the work of the past session, congratulated the Society on the reappointment of Lord Kelvin as President. This was the third time, he remarked, that the Edinburgh Royal Society had provided the Royal Society of London with a President. In referring to the successful completion of the *Challenger* Reports, for which the Society offered its heartiest congratulations to Dr. Murray, Prof. Geikie hoped that Government would be induced, by the publication of these results, to equip a proper expedition to the Antarctic regions.—Prof. Tait read a paper, by Lord Kelvin, on the application of network to a surface, in particular to a toroidal surface. Lord Kelvin had had his consideration directed to this subject, in connection with attempts to protect the pneumatic tyres of bicycles, which were examples of a toroidal surface. Dr. Noel Paton read a communication on the relationship of the liver to fats.—Mr. James Milne, gave an account of a mass of manufactured iron, which he found in the valley of the Rhone near the Glacier de la Plaine Morte. It bore the date 1807, and Mr. Milne was of opinion that it had been left there as a mark by an expedition which did some scientific work in the Alps in that year.

December 16, 1895.—Prof. Copeland, Vice-President, in the chair.—An obituary notice of the late Dr. Benjamin Carrington, by W. H. Pearson, Esq., was read by Prof. Tait.—Dr. C. Hunter Stewart, of the Public Health Laboratory, made two communications on allied subjects: Three years' daily determinations of the amount of carbonic acid in the atmospheric air, and in the ground air of Edinburgh; and on the physical and chemical examination of the soil, and the relation of the soil to the incidence of summer diarrhœa in Scotland.—

The result of his investigations on the first subject showed that the proportion of CO_2 in the atmosphere of Edinburgh in 1893 was 3·96, in 1894, 3·72, and in 1895, so far, 3·45 per ten thousand. Dr. Stewart contended that eventually the amount of CO_2 in the air depended on the nature of the soil, as the ground air was the source and regulator of the atmospheric. The ground soil of Edinburgh being clay, produced less carbon than a "travelled" and therefore porous soil. Passing to the second part of his subject, Dr. Stewart adduced statistics to show that, in the case of summer diarrhœa, the mortality was low when the soil was clay, and high when it was sandy.—Prof. Hartley, of Dublin, read a paper on the cause and nature of chemical changes in ocean deposits, and Dr. J. L. Kerr described a new method of making plaster of Paris.

PARIS.

Academy of Sciences, January 13.—M. A. Cornu in the chair.—Observations of the minor planet CH Charlois (January 8), made at the Observatory of Paris, by M. O. Callandreau.—The expenditure of energy in muscular work, by M. A. Chauveau. In the case of a muscle which is doing positive work, such as lifting a weight, the expenditure of energy by the muscle is divided by the author into two parts; one spent in displacing the weight, the other in sustaining it during the displacement. In the experimental study, the external work done in lifting a weight is measured directly, the energy changes in the muscles indirectly, by means of analyses of the inspired and expired air.—Note from the report of M. P. Ballif on the hydraulic works carried out in Bosnia-Herzegovina, and on the meteorology of the two provinces, by M. B. de la Grye.—On the variations in the ratio of the two specific heats of gases, by M. E. H. Amagat. From calculations of the values of the ratio of the specific heats of air at 50° C. under pressures varying from 1 to 50 atmospheres, widely differing results are obtained according as the determinations of the specific heat at constant volume by Joly, or those at constant pressure by Lussana, are taken as the basis of the calculation. The results of Joly are shown to be the most probable. The expression $p(v - \epsilon)^\gamma$ = constant, where ϵ is $\frac{d(pv)}{dp}$ and p, v, and γ have their usual significations, is then developed, as giving the adiabatic expansion for fluids, including highly compressed gases. For low pressures ϵ is negligible, and the equation reduces to the ordinary form.—Observations of the minor planet CH Charlois, made at the Observatory of Toulouse, by M. F. Rossard.—On the nature of the solar prominences, by M. J. Fényi.—On the generalisation of the idea of the limit, and on the extension, to summable divergent series, of Abel's theorem on complete series, by M. E. Borel.—On the theory of cathode rays, by M. G. Jaumann. A reply to a note of M. H. Poincaré. The author thinks it is not necessary to modify his hypotheses to meet the objections of M. Poincaré.—Observations on the preceding communication, by M. H. Poincaré.—On Hall's phenomenon in liquids, by M. H. Bagard. An experimental proof of the existence of the Hall effect in a saline solution. The results for a solution of zinc sulphate are of the same order of magnitude as for metallic bismuth. The experiments contradict the conclusion previously arrived at by M. Roiti, that Hall's effect did not occur with liquids.—Acetylene as a photometric standard, by M. J. Violle. As a single chemical individual of high illuminating power now easily obtained in a state of purity, acetylene offers obvious advantages as a secondary photometric standard. A flat flame of acetylene burning under a pressure of 30 cm. of water, and used with a screen, gave perfectly satisfactory results.—On the heat of formation of some compounds of manganese, by M. H. Le Chatelier. Thermochemical data are given for the combustion in oxygen of manganese, its carbide and protoxide.—On the crystallised iodides of strontium and calcium, by M. Tassilly. A thermo-chemical paper.—On aldehydes derived from the isomeric alcohols $C_{10}H_{18}O$, by MM. Ph. Barbier and L. Bouveault.—On the multirotation of the reducing sugars and isodulcite, by M. Tanret.—Retinal oscillations resultingfrom luminous impression, by M. A. Charpentier.—On the formation of the duramen, by M. E. Mer.—On a new locality in France for *Pinus Salzmanni*, by M. G. Fabre.—Pliocene glaciers in the mountains of Aubrac, by M. G. Fabre.—On some anomalies in the temperature of subterranean springs, by M. E. A. Martel.—On the mechanical production of extreme temperatures, by M. E. Solvay. A note admitting the priority of Prof. Dewar in the use of vacuous envelopes for retarding heat radiation.—On a meteor observed at Chambéry, by M. Chabert, January 6, 5.15 p.m.; direction N.E. to S.W.

BERLIN.

Meteorological Society, December 3, 1895.—Prof. Hellmann, President, in the chair.—General von Tillo, of St. Petersburg, who was present as a guest, explained a series of charts giving the chief results of his observations on the distribution of terrestrial magnetism.—Dr. Fischer described in detail a thunderstorm which occurred over Silesia and Posen on September 30. It began at midnight in a region of low temperature, advanced very slowly, accompanied by very light or even no wind, and did not cease until the next night. The storm area was covered with dense mist, rain was slight and local, and the atmospheric pressure was maximal. This storm was therefore due to neither heat nor wind eddies.—Dr. Zenker spoke on the climate of Werchojansk, with special reference to its temperatures.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Plant-Breeding: L. H. Bailey (Macmillan).—N.S.W. Government Railways and Tramways. Annual Report of the Railway Commissioners for the Year ending June 30, 1895.—First Annual General Report upon the Mineral Industry of the United Kingdom for the Year 1894: Dr. C. Le Neve Foster (Eyre).—On the Deep and Shallow-Water Marine Fauna of the Kerguelen Region of the Great Southern Ocean: Dr. J. Murray (Edinburgh, Grant).

PAMPHLETS.—Von der Menschlichen Freiheit: Dr. H. Achter (Leipzig, Engelmann).—Review of the Mineral Production in India for 1894 (Calcutta).

SERIALS.—Quarterly Journal of Microscopical Science, January (Churchill).—American Journal of Psychology, Vol. vii. No. 2 (Worcester, Mass.).—Psychological Review, January (Macmillan).—North American Fauna, No. 10 (Washington).—Journal of the Franklin Institute, January (Philadelphia).—Journal of the Sanitary Institute, January (Stanford).—Palestine Exploration Fund Quarterly Statement, January (Watt).—Intles. Archiv für Ethnographie, Band viii. Heft 5 and 6 (Leiden, Brill).—Record of Technical and Secondary Education, January (Macmillan).—Nyt Magazine for Naturvidenskaberne. 34te Binds 3 die og 4 de Hefte, 35te Binds, 1 ste, 2 de og, 3 die Hefte (Christiania).

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THURSDAY, JANUARY 30, 1896.

GROTH'S CRYSTALLOGRAPHY.

Physikalische Krystallographie und Einleitung in die krystallographische Kenntniss der wichtigeren Substanzen. Von P. Groth. Dritte, vollständig neu bearbeitete Auflage. Pp. 783. (Leipzig: Wilhelm Engelmann, 1894–5.)

NEARLY twenty years ago, in 1876, the present writer was acting as Demonstrator in Physics at the Clarendon Laboratory, Oxford, and chanced to see on Prof. Clifton's table a book just published, which differed in subject and treatment from any he had then met with. It contained in small compass (523 pages) that part of Physics which was more especially related to crystallised matter, and without delaying the reader with difficult or abstruse problems, gave in the most fascinating way a general idea of the physical and morphological symmetry of crystals. A few months later, and as a direct consequence of the interest in crystals thus aroused, the writer was advised to submit himself to Mr. Maskelyne as a candidate for the assistantship in the Mineral Department of the British Museum, just vacated owing to health-failure by Mr. Lewis, since appointed Professor of Mineralogy at Cambridge. The book was the "Physikalische Krystallographie" of Paul Groth, and the present writer is glad to have this opportunity, when giving a notice of the third edition of this useful book, to put on record his sense of gratitude to the author, a feeling which is doubtless shared by other crystallographic students in this country.

Prof. Groth was particularly well fitted for the work which he had taken in hand; he had already initiated and organised the teaching of Crystallography and Mineralogy at Strassburg (1870); gifted with great enthusiasm, he had also the rarer power of inspiring his students with the same quality; in this book he published (1876) the method which he had found to be practically useful in the course of instruction given by him as Professor of Mineralogy in that University. In the next year (1877) the *Zeitschrift für Krystallographie und Mineralogie* was started by Prof. Groth, who took upon himself the arduous duties of editor; this was the beginning of a new era for the subject. The pages of this periodical have since been at the service of crystallographic students of every country, and the twenty-four volumes already issued are a rich storehouse of the results of recent research. Succeeding von Kobell, Prof. Groth afterwards migrated to Munich, and has since completely reorganised the mineralogical collections and teaching in that University. With twenty-five years' experience as a University Professor, the editor of the many path-breaking memoirs which have appeared in the *Zeitschrift* could not fail, in the preparation of a new edition of his book, to keep his readers in touch with all that is best in the subject; and in a living subject like Crystallography, twenty years cannot pass away without the discovery of new facts and new methods, and the invention of new instruments of research.

In the case of any scientific book which is worthy of careful study, it must often be the fate of the student to react upon the author; and in this respect the present treatise is not exceptional. The treatment of the dilatation of crystals on change of temperature, as given in the first edition of the work, appeared to be out of harmony with the ideas there propounded as to crystal structure; at the suggestion of Mr. Maskelyne, the writer studied this thermal problem from a theoretical standpoint, and recorded his results in a short paper. Attracted to the subject once more, Prof. Groth had the problem practically investigated by one of his students (Dr. Beckenkamp) with the aid of the fine instrument which had then been just made for the University of Strassburg. The conclusions arrived at by Beckenkamp from his experiments, whether strictly justifiable or not is a distinct matter, were in complete agreement with those already suggested on theoretical grounds, and the variation of treatment which had been indicated was introduced by Prof. Groth in the second edition; this, indeed, was the only change of any theoretical importance at that time made. The third edition is, however, so different from those which have preceded it, that although the general aim is unaltered, the book is virtually new in its mode of treatment, and demands a more detailed notice than the new edition of a work generally calls for.

It may be remarked that the title ("Physikalische Krystallographie") suggests a more restricted survey than is actually undertaken by the author; for the morphological being regarded as likewise physical characters, geometrical crystallography falls within the scope of the book: the title is intended to be complementary to that of another treatise ("Chemische Krystallographie"), a work which Prof. Groth has long had in hand, and now looks forward to quickly completing.

A statement of the numbers of the pages allotted to the various parts of the subject will be useful as suggesting the relative degrees of importance assigned to them. The First Part begins with a discussion of the optical characters of crystals, and extends to no fewer than 163 pages; the thermal characters are allowed 24 pages; the magnetic and electrical 11 pages; the action of mechanical forces on crystals 43 pages; and the molecular structure of crystals 47 pages. The Second Part is devoted to the geometrical characters of crystals, and occupies 248 pages. The Third and last Part treats of the calculation and graphic representation of crystal forms (65 pages), of goniometers and refractometers (81 pages), and of polarising instruments (82 pages).

There are three great changes introduced in the present edition. In the first place, the optical part has been re-modelled on the basis suggested in the Tract on the "Optical Indicatrix," a work which was some time ago noticed in these columns. As stated by Prof. Groth in his preface, "the optical part is no longer based on the theory of an elastic ether, but on the purely geometrical treatment proposed by Fletcher; this method, without involving any mathematical speculations whatsoever, suffices to give even for the most complicated optical phenomena, such as conical refraction, that correct insight which is indispensable to the student in his microscopical investigations." The "Optical Indicatrix" itself, it may be here observed, was written not so much for the instruction of the ordinary student as to indicate

to the teacher a method of escape from a very awkward difficulty. Prof. Maskelyne, for whose book on Crystallography the method was devised, has the intention of presenting the method in text-book form, and of making it accessible and useful to the English student; unfortunately the many distractions of a busy public life have led to prolonged delay in the completion and issue of that part of his crystallographic treatise. Prof. Groth, however, has been quick to show that the method is one which is practically useful both to the teacher and the student; in the course of years the idea of optical elasticity will disappear from crystallographic text-books, and an unnecessary obstacle will vanish therewith from the path of the optical student. One word on a trivial matter, that of nomenclature: Prof. Groth has translated the term Indicatrix into Index-fläche, on the ground that the word Indicatrix is not acceptable in a Teutonic language. To an Englishman it is not intelligible on literary grounds why Index should be within and Indicatrix be without the limits of what is acceptable in Germany; nor were any objections to the term Indicatrix made by the German Professors (König and Ambronn), by whom the Tract itself was translated into German and rendered more accessible to the German student. In any case the constant repetition of the word "surface" in the proofs of the various geometrical propositions would make "Index-surface" unacceptable for common use in English, and it would have been a simplification of nomenclature if the term Indicatrix (*i.e.* the indicating surface) could have been adopted bodily in the other European languages.

The second great change is the total exclusion of the Naumann symbols from the text. There was much to be said for the use of the Naumann symbols in the indication of a limited number of crystallographic forms, but they are too complex in others, and are thus not generally useful: further, in the specification of particular faces and in crystal calculations, the Millerian symbol is infinitely superior, and is quite indispensable for the more advanced student. Looking to the slightness of the advantages of the Naumann symbol even in the most favourable cases, it has seemed better to Prof. Groth to now completely dispense with its consideration; this saves much valuable time to the Professor in his lectures, much space in the text-book, much unavailing toil for the student.

The third great change has involved a complete alteration of treatment of the geometrical characters of crystals. A century ago the Father of Crystallography, Romé de l'Isle, introduced the idea of a primitive form, and showed that all the crystal forms of the same kind of substance are such as could be derived from a single primitive form by similar alterations of all those parts which are geometrically similar to each other; the octahedron and the tetrahedron, for instance, were different kinds of primitive form, and were regarded as mutually independent. Later on, the idea of a primitive form was discarded by crystallographers, and that of crystalline axes, systems and symmetry, was introduced. This necessitated the recognition of symmetry as being either complete or partial in each crystalline system; and the forms presenting incomplete symmetry were treated as resulting from the suppression of half or three-fourths of the faces of forms having a complete symmetry proper to the system. Certain elements of symmetry were regarded as being then in abeyance. One educational disadvantage of this method is that the student is almost led to imagine that the axes and planes of symmetry have a physical existence anterior to that of the matter itself, and to think that the inert matter is compelled to arrange itself in a particular way through the action of these pre-existing axes and planes. Or again, he imagines that the tetrahedron was at one time an octahedron, and that it only arrived at the tetrahedral form through the excessive growth of four alternating faces of an eight-sided crystal. In the present edition Prof. Groth has followed a method suggested amongst others by Fedorow, now the Professor of Mineralogy at Moscow, and one which presents some analogy to that of Romé de l'Isle; in that, for instance, it treats the octahedral and tetrahedral symmetries as quite independent of each other. It has now been known for some decades that thirty-two, and only thirty-two, classes of symmetry are consistent with that law of whole numbers which had been discovered by Haüy to control the positions of crystal faces. This limitation of the classes of crystal symmetry was first established by Hessel in 1829, but, owing to some extent to the repellent form in which the reasoning was presented, did not then attract the attention of other crystallographers. It was re-discovered, however, by Axel Gadolin, and made known by him (1866–7) in a very lucid memoir; since that time the law has been universally recognised.

The thirty-two classes of symmetry can be grouped in various ways; and one method is that of the old so-called "systems of crystallisation." In the new mode of treatment, the six systems are merely conventional and have no structural importance; it is the thirty-two classes, not the six systems, which are fundamental, and the classes themselves are regarded as independent of each other and co-equal in importance.

In his exposition of geometrical crystallography, Prof. Groth starts from the simplest type of form, that in which there is no symmetrical repetition at all, and thence gradually advances to the most complex type, in which the existence of a single face may involve the co-existence of forty-seven others. This method, so long as it does not involve trigonometrical calculation, presents no greater difficulty than the usual mode of treatment; indeed, Prof. Groth asserts from practical experience that the student in this way makes quicker progress in the acquisition of knowledge. Each of the thirty-two classes being regarded as independent of the rest, the idea that a form may be hemimorphous, hemihedral, tetartohedral or holohedral, is completely eliminated from the science. In one respect the method actually adopted seems to the writer to fail of the desired simplicity; in the case of an ordinary crystal belonging to the Anorthic system, a crystal of albite for example, every face is accompanied by one which is parallel and opposite, and the crystal is usually regarded as having a centre, but no planes, of symmetry. For some reason not clear to the writer, Groth, following Federow, rejects the idea of a centre of symmetry, and regards such a crystal as being one in which there is no centre of symmetry at all, and every plane of the crystal, actual or crystallographically

possible, is a plane of what is termed "composite symmetry." Such an artificial and complicated method of interpreting the result of the old-fashioned centre of symmetry seems to involve its own condemnation, and to be quite unsatisfactory for the purposes of the teacher. As regards the nomenclature of the thirty-two classes, the sooner the Professors of Mineralogy can come to a decision as to the best names to be applied to them, the better for the student. Some of the names here suggested are too long to be often used: Class 28, for example, is termed the "tetraëdrisch-pentagondodekaëdrische Klasse." Though nomenclature is not of essential importance, the giving of a name is by no means a small matter; still, even a long adjective of thirty-four letters will be better than a constantly changing adjective of seventeen.

A very brief account of the researches of Bravais, Sohncke, and Schönflies, relative to the nature of crystal structure, is all that could possibly be included in a work which is to be useful to the general student; such a sketch has been given in this edition, and has had the benefit of revision by one of the great pioneers in the subject, Prof. Sohncke himself.

The above are the more important of Prof. Groth's constitutional innovations, and all that can be referred to in this brief notice. We would only add that the book is well illustrated, there being no fewer than 702 figures and three excellent coloured plates, and that it is furnished with a very complete index to its contents. By the issue of this last edition of his book, Prof. Groth has conferred one more boon on the students of Crystallography.

L. FLETCHER.

ELEMENTARY IDEAS OF MANKIND.

Ethnische Elementargedanken in der Lehre vom Menschen. By A. Bastian. 2 vols. Pp. xvi + 314; xlv + 224. (Berlin: Weidmannsche Buchhandlung, 1895.)

PROFESSOR BASTIAN has here added to his numerous works on ethnology what must be regarded as, in some sense, the crown of the edifice he has spent his life in rearing. It is an attempt to trace out the elementary ideas of mankind. For long ages every historical people, shut up within a very limited area, both physically and mentally, when inquiring through its foremost thinkers into the mental constitution of the race, had no other means of finding an answer to its questions than an analysis of the individual mind. The philosopher examined his own consciousness, forgetful that it was the consciousness of an individual in an advanced stage of civilisation, and that what might seem to him elementary, from his familiarity and the familiarity of those with whom he came into contact with it from earliest years, might really be the result of long development, or an amalgam of numerous, perhaps but slightly related, ideas. The results, therefore, of his inquiries were shifting, uncertain, in many cases absolutely untrue. And, when he came to apply those results objectively to the society in which he found himself, still greater uncertainties and divergencies of course followed. What was needed, was an external means of checking and comparing the conclusions arrived at from time to time. For want of this, the conclusions themselves remained without practical influence, or (especially, it may be added, when applied to social and political organisations) became positively disastrous. Man did not really know himself; and thinking that he did so, he often committed great and deplorable blunders.

But at last, in the gradual progress of discovery—first of geographical discovery, afterwards of scientific, and more particularly biological, discovery—the essential unity of mankind has been demonstrated. Reports of discoverers and the great ethnographical collections, formed chiefly in the capitals of Europe and at Washington, have exhibited unity, not merely physical, but mental and spiritual. It has thus become possible to set the ideas, the customs, and the organisation of the more advanced peoples over against those of the less advanced, and thus to effect that "parallelisation with equivalent corresponding existences" which gives the long-wanting means of checking the results of introspective psychology.

Starting then from the postulate of the essential unity of mankind, the veteran Professor follows the comparative method for the purpose of ascertaining in the order of conception-types, as they emerge in ethnical ideal creations, what are the elementary ideas of mankind, and thus of grasping what is involved in the totality of these conceptions, and of discerning oneself in every child of man, so far as intelligence reaches. Accordingly, although the book is addressed primarily to metaphysicians, Dr. Bastian writes not without a practical aim. A thorough comprehension of the mental and spiritual unity of mankind, a realisation of the fact that under all superficial divergencies of expression, whether in language, in myth or in custom, the same ideas, the same purposes rule in all men, and a consequent conviction that patience and tact only are required to reconcile all these divergencies by discovering their underlying identity, and tracing the devious path whereby each of them has travelled—these are qualifications not merely of the ideal anthropologist, but of the ideal statesman: qualifications more than ever necessary in these days, when discoveries and inventions have brought the foremost nations of Europe into relations of one kind or other with so many of the more backward races all over the world, making continually fresh demands on the sympathy born of knowledge to avoid difficulties and bloodshed, promote good feeling, and clear away obstacles to the progress of civilisation. Even among the civilised nations themselves, all of which have their social questions, sprung from the ferment of mutual intercourse under the influence of modern conditions, knowledge of the elementary ideas of mankind and of their expressions in social form—that is to say, in institutions—is calculated to assist materially in the solution of the problems which are now presenting themselves.

The book has, therefore, been written with these things in view; and there is no nation to which they are more important than our own: none, perhaps, to which they are so important. Yet the British Government has done less than any towards the systematic study of anthropology. The Imperial Institute might have served the purpose of a great national school of anthropology, where the rulers of our subject-peoples could be trained. It has been turned, instead, into a second-rate club. Meanwhile, those whose mission it is to direct the destinies of

tribes remote and strange alike in space and in culture, remain in total ignorance of the ideas which govern them, or are driven to acquire what little information they may ultimately obtain in the course of years by actual contact and repeated mistakes, learning their business at the expense of the unfortunate savages they are set to manage, as well as at ours, or else to seek for it in a desultory way without a trustworthy guide through that vast and tropical wilderness, the literature of travel and research.

Unhappily it cannot be said that the book before us will be of very much use to such inquirers, or to many anthropological students in this country. Addressed, as I have said, in the first instance to metaphysicians, it is written in an involved and allusive style, bristling with metaphysical technicalities; and the learned author has too little respect for his readers to assist them by dividing his work into chapters or sections, or to give them more than, at most, the bare names of the authorities for his numerous citations. What good is there in telling us vaguely, in a little aside, "see Hiekish," or "see Schwebel," or "see Swan"? We want to be able to verify the statements, and test the use that is made of them; and the scientific writer, be he professor with world-wide reputation, or obscure student, who neglects to enable us to do this, foregoes half his title to our confidence. Some of these faults, indeed (especially the last), disfigure all the author's works. To call attention to them is not a pleasant task; nor do I deny—I cordially acknowledge—Dr. Bastian's many claims on our gratitude and admiration. At the same time, a protest in favour of lucidity and exactness is all the more needful where the transgressor is so able and so justly distinguished as Dr. Bastian.

E. SIDNEY HARTLAND.

THE BIRDS OF GREEK LITERATURE.

A Glossary of Greek Birds. By D'Arcy W. Thompson, Professor of Natural History in University College, Dundee. Pp. xvi + 204. (Oxford: Clarendon Press, 1895.)

BOSWELL once told Johnson that he had a plan for collecting the poetry of the Border, a task which he fortunately left to be undertaken by a more skilful hand. Not indeed that he feared he would be unequal to it, but, as he told his master, he doubted whether it would be of much good to any one. "Sir," replied the sage, "never mind whether it is going to be any good to any one: do it." It is in the spirit of this answer, that Prof. D'Arcy Thompson has been for years accumulating the material brought together in this volume. He must have often had doubts as to the practical value of his labour, and as to the reception it would meet with from scholars on the one hand, and scientific men on the other. The region of scholarship invaded by a Professor of science, the precious time of a scientific researcher given up to laborious reading of a voluminous Greek literature! It is true enough that if called upon to explain to any ordinary man of business what the value of the work is, we should find it hard to do so; yet we feel all the more disposed to admire the indefatigable perseverance which has carried the author through his self-imposed task to its completion, dogged as he must have been by the sense that he was travelling all the time in a mist, where no certain conclusions could be drawn as to bird, or legend, or etymology.

Yet it would be by no means true to say that the book will be of no practical value. In the first place, it is compiled with such laborious thoroughness, that it will serve as a thesaurus of reference and information for all scholars who may have to deal with passages in Greek literature relating to birds; and such passages are abundant. Their difficulty often arises from the tangle of myth which grew up around certain birds, *e.g.* the Hoopoe, the Cuckoo, the Nightingale, &c.; and what a scholar needs for the elucidation of his author, is a handy book of reference to all that has been written or bears on the matter, both in ancient times and modern. Here is exactly the book for him; he will find (so far as I am able to judge) the whole available material in two or three pages. It matters little whether the guesses, combinations, conclusions are sound or not; it is the collection of material that will be really valuable. Nor is the pure scholar the only workman who may profit; the numismatist, the mythologist, the student of the ancient science of divination, may find their advantage in this volume.

The method adopted by the author makes reference to the glossary quick and easy. He begins with the identification of the species where it is at all practicable; sometimes, perhaps, stating it too definitely, and without the necessary warning-note for too precipitate readers. An etymology sometimes follows, which is, indeed, as a rule, superfluous; for no scholar will in these days listen to any one but a specialist in a science so difficult as comparative philology, and the attempts are here often obviously unscientific. But no harm is done in this way, for I have noticed hardly a case in which any serious conclusion is built upon an etymology—a form of Teutonic crime familiar to all scholars. Then follows the description of the bird, beginning with Aristotle as a rule, cited, as he should be, from the paging of the Bekker edition: and so onwards to the later Greek writers. Here a critic must point out that a list of the writers quoted, with their date and the edition used in the compilation of this work, would have been a great convenience to the student; for the Professor's reading has been so insatiable, that he sometimes quotes authors of whom even a good Greek scholar may never have heard in his life. Then come the habits of the species, *e.g.* nesting, song, migration, each point being clearly distinguished in a separate paragraph; and lastly, the myths attaching to the bird, with an attempt, instructive if not always convincing, to elucidate them. This account of the method pursued applies, it need hardly be said, only to those species which especially attracted the attention of the Greeks: *e.g.* the eagle, cock, kingfisher, crane, nightingale, swallow, &c. The great majority of glosses are naturally very brief.

Undoubtedly the most striking and interesting parts of the work are those in which the author ceases for the moment to be a compiler, and offers us a new key to the interpretation of certain myths. "I offer," he says in the preface, "a novel, and at first sight a somewhat startling explanation: to wit, that many of them (*i.e.* the fables about birds) deserve not a zoological but an

astronomical interpretation." For example, the story of the halcyon days is hypothetically explained in this way: it "originally referred to some astronomical phenomenon, probably in connection with the Pleiades, of which constellation Alcyone is the principal star" (p. 31). A criticism of any one such explanation would be impossible in a limited space, even if the present writer were qualified to undertake it. Suffice it to say, that even if it could be proved that every one of these interpretations is wrong, and that simpler methods are applicable, yet credit would be still due to the man who indicated a possible way of dealing with these difficulties, and one which would not be likely to occur to the ordinary book-scholar. We must of course be on our guard against the danger of missing our footing while we thus gaze into the heavens for a missing clue; but I venture to say that any one who will carefully study the whole of the passage from which a sentence was just now quoted, or that in which is discussed the fable of the Swan and the Eagle, will hardly avoid the conclusion that there may be an astronomical aspect of the folk-lore of some peoples, which has still to be scientifically investigated.

In conclusion, it may be asked what contribution there is in this volume to zoological science. Positively and directly, there cannot well be any; the identification of species is in most cases too doubtful to allow us to compare them with those now familiar to us in regard to distribution, migration, nesting habits, &c. But, as a contribution to the history of the science, this book will be of great value, and the future editor of Aristotle's *Historia animalium* will find himself relieved by it in many particulars from a great deal of tedious research.

The revision of the proofs has evidently been carried out with scrupulous care—no easy task, considering the innumerable proper names and Greek quotations; and the accentuation of Greek words seems to be remarkably accurate. In a few unimportant points, I should differ from the author's views; but of these I will only mention one, about which I am confident. He declines to identify Aristotle's σχοινίλος as the reed bunting, on the ground that that species (*Emberiza schœniclus*) does not flick its tail as other buntings do. But the reed bunting *does* flick its tail, as I have every reason to know, and I believe the old identification to be probably right. I may just add that I see no difficulty in identifying Aristotle's κύανος with the wall-creeper, though he says that it is κυανοῦς ὅλος; for the Greeks were weak in discriminating colours, and I can testify that it is not so easy as one might expect to catch the crimson of the wing-coverts when the bird is on a rock high above you. And it is not likely that the Greeks should have been able to procure specimens of this shy species for closer examination.

W. WARDE FOWLER.

OUR BOOK SHELF.

Polyphase Electric Currents and Alternate Current Motors. By S. P. Thompson. Pp. vi. + 261. (London: E. and F. N. Spon, 1895.)

THIS book resembles others by the same author, in being an amplification of a course of lectures. Every one who knows Prof. Thompson's later work, will expect to find evidence of a good deal of study; nor will he be disappointed. Not the least important part of the book is the list of works and articles which have been written upon this comparatively new department of electrical engineering. A chapter and many other paragraphs are of an historical nature, and if in some cases those who have been behind the scenes more than the author, may consider that he has not been quite fair in his conclusions, yet every one will admit that impartial fairness has always been aimed at by Prof. Thompson.

Here and there a little more care might have been exercised. On p. 24 the lettering on Fig. 28 is wrong. The views of M. Goerges on the comparative economy in copper when used with one, two, and three phases is not at all clearly put. The author has a liking for new terms. The "stator" and "rotor" of a dynamo or motor have an unpleasant sound, and are not so good as the French "inducteur" and "induit," but they will serve their purpose. "Star" and "mesh" groupings do not explain their meaning (referring to the connections for a three-phase system) so well as the old and appropriate symbols Y and Δ.

The mathematical theory of polyphase systems has been worked out by many writers and on different lines. The method selected by the author has the merit of being simple, and easily followed by those who do not handle mathematics easily. The parts of the book which relate to the design of machinery are not very complete, and would hardly suffice to enable the average electrical engineer to make a good polyphase dynamo or motor. But we must remember that this was a fault of the first edition of "Dynamo Electric Machinery," by the same author, which has steadily improved with each new edition, and has become one of the leading text-books of its kind. So, also, we expect that the book before us has in it at least the germ of a treatise which will be a standard work of great value as it passes through successive editions. As it stands, the book should be on the shelves of all those who are engaged in developing that most useful auxiliary of the electrician, a polyphase system for distributing electrical motive power.

G. F.

Elementary Physical Geography. By R. S. Tarr, B.S., F.G.S.A. (New York and London: Macmillan and Co., 1895.)

THE most prominent feature of this book is the wealth and excellence of its illustrations; in less than 500 pages there are close upon 300 of them, many being new, while numerous others are from official publications which are not accessible to most elementary students. The admirable photographic reproductions, illustrating a great variety of natural phenomena, are especially noteworthy, as are also the illustrative maps. The three main divisions of the book treat of the atmosphere, the ocean, and the land. Strangely enough, "the earth as a planet" falls into the first division, and meteorological instruments and methods are relegated to an appendix. "To present facts and furnish information" is the avowed object of the book, and although it is recognised that "the average mind learns unconnected facts with much less ease than those which are philosophically related," many objections to this method of teaching might be made. One of the defects of the method is the liability to employ terms without sufficient explanation, and we find the author so using the terms "waves of ether," specific heat, density, and temperature. Again, a student would be very much wiser for a demonstration that the air has weight, than for a mere statement of the fact. It is true that the introduction of laboratory and field work is strongly advocated, and some very useful suggestions for such work are made. If the facts and information furnished by the book are supplemented by laboratory and field study, the course may be made one of great educational value. Otherwise, to use the author's words

"the value of the study will be very slight indeed," as a means of mental discipline. Nevertheless, the logical sequence of subjects, and the statement of sufficient evidence to justify the conclusions drawn as to the causes of many natural phenomena, combine to provide a useful course of reading. The information is fairly up-to-date, and the descriptions are clear as well as interesting. References to the literature of the various parts of the subject, and questions for examination, will greatly increase the value of the book to teachers.

An Introduction to the Study of Seaweeds. By George Murray, F.L.S. (London: Macmillan and Co., 1895.)

IN this little volume, one of the Manuals for Students Series, we have a fairly satisfactory account of those forms of Algæ which live in salt water. We had fancied that the English name "seaweed" had by this time lost its first or original meaning, and that it had come to be considered as equivalent to Algæ, in its widest sense; but Mr. Murray has drawn the line between those forms which live in fresh and those which live in salt water, and whenever it is possible he avoids all reference to the former. This being so, there is no account of the lovely Desmids, nor of the interesting species of Bulbochæte and Œdogonium. Noting this as a fact, but one to be regretted so far as the Chlorophyceæ, which "attain their finest development in fresh waters," are concerned, we welcome this little book as a useful and pleasantly written introduction to an ever-fascinating group of plants, which are easily, for the most part, preserved and are equally easy of observation. Their life-history, despite that many of them are so common, has still many a secret, which it will take long and patient research to find out. The introductory chapter condenses a great deal of valuable information into a few pages, and is accompanied by a useful list of books and memoirs on seaweeds.

Beginning with the Phæophyceæ, and with their more specialised forms, the Chlorophyceæ come next in order, then the Diatomaceæ, followed by the Rhodophyceæ, and ending with the Cyanophyceæ. Eight well-drawn and neatly-coloured plates illustrate the volume, which also abounds with numerous woodcuts; most of these latter are satisfactory, and all of them are selected from modern and authentic sources.

We trust that this help to a study of these "seaweeds" will be successful in attracting many to their study. When the late Dr. Harvey was writing his well-known "Phycologia Britannica," he had a very numerous set of correspondents, living on all parts of our coasts; some of them, like Mrs. Griffiths and Miss Hutchinson, were excellent botanists, but most of them were excellent observers. Is it too much to expect that others may arise to take their long-left places?

Public Health in European Capitals. By Thomas Morison Legge, M.A., M.D. (Oxon), D.P.H. (Cantab.). Pp. vi + 202. (London: Swan Sonnenschein and Co., 1896.)

THE author points out in the preface that the work is a record of his own observations during many visits to "some of the most important capitals on the continent"; and a very interesting and instructive record it is.

The cities dealt with are Paris, Berlin, Brussels, Christiania, Stockholm, and Copenhagen. It will be noted that several important capitals (Vienna, St. Petersburg, Rome), and many others the sanitation of which would be interesting, if not edifying, are omitted. It is to be hoped that Dr. Legge will be able to include these in a subsequent edition, for he has shown in the present volume that he can interest while he instructs.

A comparison is set forth of the methods employed in different countries for coping with the great problems of sewage disposal, water-supply, the spread of preventible disease, and the housing of the poor; and it is a work that can be read by all who take an interest in these vital subjects, for the information it conveys is not set in abstruse technical language. The book presents many instances of the experts of different countries differing in their methods and views, but the differences are mainly those of detail in the application of great principles of sanitation that are equally recognised by all.

The writer is perhaps at his best when treating of Paris. In that city, during the past two years, some much-needed sanitary improvements have been inaugurated; but it is only fair to our neighbours to concede that their appreciation of the principles of sanitation have for many years been in advance of that of a certain French judge, who, as Dr. Legge tells us, declared, as recently as 1885, that for a landlord to be compelled to lay on water to his house for the use of the tenants was an interference with the liberty of the subject, and that a water-supply was not an indispensable necessity for maintaining the healthiness of a dwelling.

It is a source of satisfaction, while reading of the various capitals, to find that, in matters relating to the public health, London is certainly *facile princeps.* In one particular, however, we fall far behind some other capitals, and that is in the matter of meat inspection. The sooner we adopt the Berlin system of skilled inspection of the live animals in public abattoirs, and the detailed examination of the carcases, the sooner shall we remove what is a very great reproach upon the thoroughness with which our methods of disease prevention are carried out in this country.

History of the Cholera Controversy. By Sir George Johnson, M.D., F.R.C.P., F.R.S. Pp. 78. (London: J. and A. Churchill, 1896.)

SIR GEORGE JOHNSON has held for years, as is well known, very strong views as to the treatment of cholera, and the above little volume, with its seventy-eight pages, is devoted to an elaborate exposition of these views, together with an account of their reception by the medical world. The so-called "Cholera Controversy" gathers, we are told, round the support given respectively to the "evacuant" and "astringent" treatment of this disease; or, in other words, the use of castor-oil *versus* opium in the handling of cholera cases. It is not possible here to enter into the various medical arguments and discussions which occupy these pages; but we cannot help regretting that in the treatment of this subject, the author has allowed the personal element to play so conspicuous a part, as it detracts from the value of its discussion and tends, necessarily, to restrict the area of observation. Thus it would have been of interest to have had some reference to the latest official document published last year in Germany on cholera, from which we should have learnt that calomel is frequently referred to as of great therapeutic value. The "historical" side of the question would thus not only have gained in interest, but the arguments, from a layman's point of view, would have been more convincing.

Mechanics. Part iii. *Hydrostatics.* By R. T. Glazebrook, M.A., F.R.S. Pp. x + 213. (Cambridge: University Press, 1895.)

A CLEARLY-PRINTED and well-arranged text-book of hydrostatics for colleges and schools. The subjects and order of the eight chapters are: states of matter, fluid pressure, propositions of fluid pressure, fluid-thrust centre of pressure, floating bodies, measurement of specific gravities, pressure of the atmosphere, hydrostatic machines. The descriptions are clearly written, and the exercises are numerous. Moreover, the treatment is experimental; so that altogether the book is calculated to give a good grasp of the fundamental principles of hydrostatics.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Prints of Scars.

THE accompanying print is sent with a two-fold object. First, for its intrinsic interest in showing how thoroughly and definitely a grafted slice of skin and flesh has established itself under its new conditions, retaining its original characteristics unchanged during thirty years. Secondly, because of its probable interest to surgeons in illustrating the ease and completeness with which a record can be kept of the process and results of the cicatrisation of wounds.

Prints are more clear, more cheap, and more trustworthy than photographs. They are not distorted through perspective, nor blurred owing to differences of focus; they can be taken in any light, and their scale is absolutely correct. They are made by rolling the scarred part on a porcelain pallet or metal slab, that has been covered evenly and very thinly with printer's ink; or, conversely, the pallet and paper are rolled upon the scar. As many duplicate prints can be taken as desired. I have written at so much length about these and alternative methods of printing in my book, "Finger Prints," and elsewhere, that I need say no more about them now. The print sent herewith is a photographic

Enlarged print of a misplaced graft of flesh on the side of a thumb, thirty years after it was made.

enlargement, being more suitable for rough process-printing than the somewhat minute originals; but one of these is also enclosed. The history of the graft is as follows: J. R. H., who is a solicitor in large practice, when he was twenty-five years old, sliced a piece clean off the thumb of his left hand. He was cutting cardboard with a sharp knife guided by a rule, upon which the thumb pressed, and which it slightly overlapped. The piece that was cut off fell on the table; it was at once picked up, clapped upon the wound, and the thumb was tightly bandaged. After a few days reunion had taken place, and the wound was healed. It then proved that the graft had not been replaced in its original position, but crossways to it, as seen by the papillary ridges in the accompanying print, taken in 1895, thirty years after the accident. FRANCIS GALTON.

The Cause of an Ice Age.

SIR ROBERT S. BALL appears to admit the correctness of Mr. Culverwell's argument against Croll's astronomical theory of an Ice Age so far as, that "the direct sun-heat received on any parallel at the time of greatest eccentricity is the same as that now received on the parallel not more than three or four degrees north"; and then proceeds to explain, with perfect truth, that "the actual temperature in a region depends, not merely upon the sun-heat there received, but also upon the transference of heat across the boundaries of that region."

Now the causes upon which the transference of heat depend, viz., the prevailing winds and the ocean currents, rest ultimately upon the sun-heat received over the whole globe. The soundness of Mr. Culverwell's argument therefore seems to hinge upon whether the general shift of the isotherms of *sun-heat* three or four degrees southward would be incapable of greatly altering the winds and currents. If this were so, it might be admissible to reason upon the sum total of the local climatal effects at a period of great eccentricity, with the winter in aphelion, from the conditions of temperature as they now exist. If a shift three or four degrees southward would not appreciably alter these currents, I think Mr. Culverwell's argument against Croll's theory a strong one; and to reply effectually to it, it ought to be explained that such a slight shifting of the isotherms of sun-heat would be likely to affect those currents to so great an extent that the then conditions of local temperature would not bear comparison with the present—as, for instance, of Cornwall then with Yorkshire now. O. FISHER.

Harlton, Cambridge, January 17.

Barisal Guns and Similar Sounds.

IN Colonel Godwin-Austen's interesting letter on the Barisal guns (page 247 *ante*), he mentions as suggested sources of these remarkable sounds fireworks (*i.e.*, bombs, cannon), bursting bamboos in jungle-fires, thunder-claps, landslips, the falling of river-banks or sand-banks, and seismic disturbances; but he does not add what seems to me to be a more probable source of the sounds, namely, ball or globular lightning, known to the French as *éclairs en boule*.

It is true, as I stated in my letter to the *Times* in August last, that Faraday, so late as 1838, said:—"That phenomena of balls of fire may appear in the atmosphere I do not deny, but that they have anything to do with the discharge of ordinary electricity, or are at all related to lightning or atmospheric electricity, is much more than doubtful." ("Researches," sec. 1641.)

Snow Harris, however, in his book on "Thunderstorms," 1843, recognises the phenomenon as a case of glow discharge, often terminating in disruptive discharge, as in the case of H.M.S. *Montague*. After this, the reported cases of ball-lightning and the damage caused by their violent explosion are numerous, and some remarkable ones have been described lately in NATURE. When of lower tension, these fire-balls, as they were called by the older physicists, may envelop the person without doing any harm, a striking example of which is given in Shakespeare's *Julius Cæsar*, Act i. Scene iii.

The explosive sounds heard by the Rev. W. S. Smith, while skating on Lough Neagh, may still be due to globular lightning. The dry atmosphere occasioned by frost is highly favourable to the development of atmospheric electricity; and we have still to learn whether these electrical globes will not account for the observed phenomena. C. TOMLINSON.

Highgate, N., January 20.

IN connection with the correspondence on mysterious atmospheric sounds, which originated with Prof. Darwin's communication in the issue of NATURE for October 31 last, I have official sanction for forwarding the following extracts from the meteorological logs of vessels visiting high latitudes.

S.s. *Resolute*, Captain W. Deuchars; 8 p.m., July 30, 1883, in 71° 9′ N., 12° 28′ W.—"Six reports like those of guns heard to the westward, supposed to be caused by electricity, as no ships are thought to be in the vicinity." Wind during the day calm to very light easterly airs; weather foggy; sea smooth, with a very slight south-easterly swell; pressure and temperature as follows:

	Barometer.	Air temperature. Dry bulb.	Damp bulb.	Sea temperature.
	In.	°	°	°
Noon	30·08	50·0	48·8	41·5
4 p.m.	30·09	42·0	41·8	37·0
8 p.m.	30·10	40·8	40·5	37·0
Midnight	30·11	46·5	46·5	35·0

S.s. *Windward*, Captain A. Murray; 4 a.m. June 12, 1883, in 71° N., 7½° W.—"There is a distinct murmur as of a waterfall from the island" [of Jan Mayen]. Calm; weather foggy;

sea very smooth; barometer 29·83 in., rising; temperature of air 33°, of sea 34°.

S.s. *Labrador*, Captain A. Gray; July 14, 1882, about 56° N., 60° W.—"Saw an iceberg, which collapsed with a thundering squash." Next day, "icebergs all over the place, with an occasional collapsing roar."

It may be thought, perhaps, that the thundering roars of collapsing bergs would be the explanation of the six reports heard by Captain Deuchars; but as he had many years' experience whaling and seal fishing in the ice on both sides of Greenland, he would be well acquainted with the sounds from bergs breaking up, and there must have been, therefore, something peculiar about the "guns" to lead him to suggest an electrical origin.

With reference to M. Van den Broeck's explanation of the expression *mist-poeffers* as *fog-belchings*, not *fog-dissipators*, it may be interesting to add another extract from Captain Deuchars's log: June 15, 1883, in 71° N., 11° W.—"Weather dense fog, with a white bow to south-east, known generally as a *fog-scaffer* or *demolisher*." HY. HARRIES.

Meteorological Office, January 17.

WITH reference to the letters on this subject which have recently appeared in your pages, and more especially to the communication of my friend Rev. W. S. Smith, relative to Lough Neagh, the following extract from my notes may be of interest: "August 27, 1886.—While standing with Mr. S. A. Stewart in a recently-mown meadow, near Portmore Lough, on the eastern side of Lough Neagh, our attention was attracted by a rumbling noise. The day was very fine and warm, and dead calm, not a leaf stirring, and a few very light clouds were in the sky. The noise was like a short distant peal of thunder, but sounded faint rather than distant. While we watched, a whirlwind suddenly appeared in the direction whence the sounds had come [the north], and at a distance of about a hundred yards from us. A quantity of loose hay was instantly whirled upward to a height of about 100 feet, and, after floating about in circles, slowly settled down. A haycock at the spot was much disturbed, and presented the appearance of having endured a gale of wind. The time between the rumbling sound (which closely resembled the distant report of a cannon) and the appearance of the whirlwind was about half a minute, and the whirlwind lasted somewhat over a minute."

In W. H. Patterson's "Glossary of Words of Antrim and Down," we find the following: "Water Guns.—Sounds as of gunshots, said to be heard around the shores of Lough Neagh by persons sailing on the lake. The cause of the sounds, which are generally heard in fine weather, has not been explained." There is no doubt that the sound we heard was the mysterious "water guns," and there is also little doubt that the noise and the appearance of the whirlwind were closely connected.

R. LLOYD PRAEGER.

IN connection with the recent correspondence upon "Remarkable Sounds," the following quotation may be interesting. It occurs as a footnote in a paper by Prof. S. A. Forbes, of Illinois, upon the "Aquatic Invertebrate Fauna of the Yellowstone National Park, &c.," published in the *Bulletin* of the U.S. Fish Commission for 1891 (Washington, 1893), p. 215.

"Here we first heard, while out on the lake [Shoshone Lake, Yellowstone National Park] in the bright still morning, the mysterious aerial sound for which this region is noted. It put me in mind of the vibrating clang of a harp, lightly and rapidly touched, high up above the tree-tops, or the sound of many telegraph wires swinging regularly and rapidly in the wind, or, more rarely, of faintly-heard voices answering each other overhead. It begins softly in the remote distance, draws rapidly near with louder and louder throbs of sound, and dies away in the opposite distance; or it may seem to wander irregularly about, the whole passage lasting from a few seconds to half a minute or more. We heard it repeatedly and very distinctly here and at Yellowstone Lake, most frequently at the latter place. It is usually noticed on still, bright mornings not long after sunrise, and it is always louder at this time of day; but I heard it clearly, though faintly, once at noon, when a stiff breeze was blowing. No scientific explanation of this really bewitching phenomenon has ever been published, although it has been several times referred to by travellers, who have ventured various crude guesses at its cause, varying from that commonest catch-all of the ignorant, 'electricity,' to the whistling of the wings of ducks and the noise of the 'steamboat geyser.' It seems to me to belong to the class of aerial echoes, but even on that supposition I cannot account for the origin of the sound." D. J. SCOURFIELD.

Leytonstone, January 20.

IT may be worth while to put on record the following statements of the distances at which the firing of guns have been heard. They were related to me by the late Prof. C. J. Harris, of Washington, and Lee University, Lexington, Virginia, who, in speaking of the distances at which sounds could be heard, said that during "The War"—the Civil War of 1861–65—he had frequently heard the firing of the guns in battles taking place many miles from Lexington; and so distinct were the reports, that it was easy to distinguish between light and heavy artillery. In particular, I remember his saying that the sound of the cannonading at the Battle of Malvern Hill was distinctly heard at Lexington. Malvern Hill is about 123 miles "as the crow flies" from Lexington. At this battle gunboats were used by the Federals, and the reports of the heavy guns on the boats could be easily distinguished.

He also said that during the Battle of Manassas—or, as it is also called, Bull Run—the cannonading was heard at Lexington. The battle-field is about 125 miles from Lexington. These distances have been furnished me by the Assistant Superintendent of the U.S. Coast and Geodetic Survey, and are accurate within a mile or two. W. G. BROWN.

Washington, D.C., U.S.A., January 3.

The Place of "Pithecanthropus" on the Genealogical Tree.

WRITING to NATURE (January 16), under the above heading, Dr. Eugene Dubois makes the following statement: "In Prof. Cunningham's tree, figured in NATURE of December 5, p. 116, he regards the left branch as all human, the right one as entirely simian, and he placed Pithecanthropus midway between recent Man and the point of divarication." In this assertion there are two inaccuracies. I do not regard the left branch as being entirely human, but merely as representing a hypothetical line of human descent. During the debate which took place at the Royal Dublin Society, I was most careful to insist that at a certain point on such a line (marked on the diagram by a ×, NATURE, December 5, p. 116), we might expect to meet with an individual possessing ape-like and human characters in equal degree; whilst below that point ape-like characters would predominate, and the human characters diminish until, probably, before we came to the junction of the line with the main stem, the latter had reached a vanishing point. But, again, I did not place Pithecanthropus on the mid-point of the line, but much lower down, as may be seen by a reference to the diagram itself, where the upper mark of interrogation (?) indicates the place which I assigned to the fossil cranium.

I would wish to add that my diagram was not drawn with the view of elaborating in any detail a genealogical tree of Man and the Anthropoid apes, but simply for the purpose of eliciting from Dr. Dubois his views regarding the place he wished to assign to Pithecanthropus in relation to Man on the one hand, and the existing Anthropoid apes on the other.

It seemed to me that a definite statement from Dr. Dubois on this point was desirable, seeing that I considered that the title he had given to his memoir was apt to lead to misconception. D. J. CUNNINGHAM.

THE CHEMICAL SOCIETY'S HELMHOLTZ MEMORIAL LECTURE.

IN his Helmholtz memorial lecture, delivered last Thursday, Prof. G. F. Fitzgerald gave an able exposition and development of those branches of the work of the late Prof. Helmholtz which intimately affect chemistry, and at the same time made an important contribution to several much-vexed questions of higher chemical physics. A brief account of the chief points of the lecture is given in the following abstract.

Helmholtz made the great discovery that, by virtue of their vorticity, vortex rings floating in a perfect fluid are unable to destroy or create one another; although these vortices may distort each other, becoming drawn out into thin threads or rolled into spherical balls, one cannot destroy another. This discovery it was that afforded a basis for those speculations of Lord Kelvin which would identify atoms with vortex rings moving in a perfect fluid; the indestructibility of atoms finds a parallel in the permanency of vortex rings, and the two have many properties in common. As, however, our knowledge of vortices has increased, so obstacles to the acceptance of the atomic vortex hypothesis have arisen. Thus the energy and the inertia of vortex rings increase together whilst their rate of motion decreases, so that on raising the temperature of a gas composed of vortex atoms, and therefore increasing the rate of motion of its particles, it would seem that, in some mysterious way, more energy leaves the gas than enters it. Similarly, unless the weight of a body alters appreciably as its temperature changes, it is not easy to see how the simple vortex theory of matter can be true; the difficulty of determining weights at different temperatures of course stands in the way of an experimental examination of this point. Many modifications of the vortex theory have been proposed, but the only statement that can be made with certainty is that the space between the atoms, whatever their nature may be, must be filled with some complicated structure, the postulation of which is essential for the explanation of electro-magnetic actions. It is therefore impossible to believe that atoms are simply thin vortices floating in an otherwise motionless and structureless medium.

A curious analogy is noticeable between the stability of vortex systems and chemical valency. A system of two vortex rings, both rotating in the same direction, assumes a state of fairly stable equilibrium in which the two rotate round one another, whilst a system of three vortex rings is stable in a state in which the vortices are situate at the apices of a triangle. Similarly, a condition of stable equilibrium is possible for systems of four, five, or six rings; a system of seven vortex rings, however, is unstable, and vortex systems generally become unstable when composed of more than six rings. The curious analogy between this result and the fact that the atom of no chemical element requires to combine with more than six monovalent atoms, should be kept in view in default of a sounder dynamical conception respecting the limitation of chemical bonds.

The atomic vortex theory again meets with difficulties in connection with homologous series of organic compounds and with the atomic weights; the atomic weight of mercury is 200, that of hydrogen being unity, and it can be shown that the volume occupied by the mercury atom should be some 2800 times that occupied by the atom of hydrogen, a result hardly reconcilable with the known properties of these elements. Valency also presents obstacles to the theory; thus nitrogen and carbon should be respectively mono- and di-valent unless the vortex rings are doubled on to themselves, and even then the doubling indicates the existence of two allotropic modifications of carbon, a right- and a left-handed form, for which no evidence exists. The vortex theory of atoms and the experimental facts regarding atoms are thus sadly at variance, and much still remains to be done in clearing up the questions at issue.

The theory of semipermeable membranes, which is of such importance in certain branches of physical chemistry, is as yet in a very unsatisfactory state. The absolute disregard of any possible heating effects occurring during osmosis may lead to serious errors, corresponding to those which crept into the theory of galvanic cells by neglect of the thermal effects which arise when electrical currents enter or leave a liquid; possible causes of error, such as these, should be well borne in mind until the theory and practice of semipermeable cells are in better agreement than at present. These semipermeable membranes are frequently regarded as being only some kind of molecular sieves, although they are really much more analogous to Graham's second class of membranes, which only allow the passage of gases soluble in the membrane itself; the laws governing the two kinds of membranes are quite dissimilar. It is not easy to sharply distinguish between physical and chemical permeability when molecular magnitudes are dealt with, and one molecule may pass amongst others not so much by reason of possessing the right size as the right shape. There seems some hope of extending our methods of "chemical filtration" by means of sets of properly constituted diaphragms, each of which is penetrable by certain classes of molecular groups.

The application of thermodynamics to chemical investigations is full of pitfalls; the law of conservation of energy has been often misapplied, and it is not sufficiently realised that the second law of thermodynamics is not strictly applicable to irreversible chemical changes, such as explosions, &c.

The tendency to regard chemical forces as electrical ones is not altogether justifiable; too many instances of irreversible chemical changes exist to permit a parallel between chemical actions and simple reversible electrolysis. Chemical actions are of a far more complex nature than simple electrolysis, and that other than purely electrical forces are operative in solution is indicated by Helmholtz's investigations of electrical diffusion through fine tubes. No statical theory of solid or liquid media which supposes the action of none but electrical forces is possible, for such media would be essentially unstable; as far, then, as solids and liquids can be conceived as statical systems, the postulation of other than purely electrical forces is imperative. The success which has attended the accepted theories of crystal structure and of the asymmetric carbon atom, makes it pretty safe to conclude that many properties of molecules are deducible from purely statical theories of structure.

The enormous increase of knowledge which has attended the assumption that a substance in liquid solution behaves in some important respects like the same substance in a pure gaseous state, has led to the grave error of supposing that the physical conditions of molecules of a substance when gaseous and when dissolved are similar. A dissolved molecule is always within the spheres of action of countless neighbours; its path is of the order of one-hundredth of its diameter, and it receives, perhaps, 10^{14} blows per second, so that its vibrations are comparable with those of radiant heat; in the gaseous state, however, the molecule has a free path thousands of times its diameter in length. The dynamical conditions of gaseous and dissolved molecules are thus absolutely dissimilar. Although it is curious that the osmotic pressure of a dissolved substance should be even roughly identical with the vapour pressure of the same quantity of the substance as a gas under similar conditions of volume and temperature, it is wholly erroneous to attribute this coincidence to a similarity between the dynamical states in the two cases. Osmotic pressure is more nearly related to Laplace's internal pressure in a liquid, which depends on intramolecular forces, than to a gaseous pressure which is practically independent of the forces operating between the molecules. Considerations respecting the capillarity and vapour pressure of solutions and solvents shows that some very close connection exists between osmotic pressure and capillarity, and afford a trustworthy method of applying thermodynamics to the calculation of osmotic pressure.

It is almost impossible to explain dynamically the assumption that free electrically charged ions wander about in a liquid in a condition at all rightly described as one of dissociation. The term "dissociation" should

be restricted to a condition in which the components of a molecule are in no way connected by chemical bonds; the possibility of the independent diffusion of the molecular components through porous membranes would afford a simple test as to whether molecules were really dissociated or not. The term dissociation as applied to electrolytes, in which this independence of the ions does not exist, is obviously a misnomer. There is said to be an electrical force acting between the various oppositely charged ions into which a dissolved molecule separates, which in some way still binds them. Even in dilute solutions this force is very considerable, and must make the condition of charged ions moving independently in the liquid so unstable as to be dynamically impossible unless other important forces operate at the same time. Although the present theory of free ions affords a rough working analogy, yet it is illusory and misleading, and threatens to prevent important advances by its illusive appearance of explanation. It must not be forgotten that the older theories of light and the caloric theory of heat constituted stumbling-blocks long after their inadequacy had been conclusively demonstrated.

Prof. Fitzgerald thus contends that the fundamental conceptions underlying many of the current physico-chemical theories, such as those of osmotic pressure and electrolytic dissociation, are dynamically unsound, so that all attempts to gain an insight of what occurs in solution by their aid are necessarily unsuccessful. He seems to consider that an unyielding adhesion to these theories has led to an illogical habit of thought upon such matters, and has made possible the inaccurate application of thermo-dynamical reasoning. W. J. P.

NEW EXPERIMENTS ON THE KATHODE RAYS.[1]

(1) TWO hypotheses have been propounded to explain the properties of the kathode rays.

Some physicists think with Goldstein, Hertz, and Lenard, that this phenomenon is like light, due to vibrations of the ether,[2] or even that it is light of short wavelength. It is easily understood that such rays may have a rectilinear path, excite phosphorescence, and affect photographic plates.

Others think, with Crookes and J. J. Thomson, that these rays are formed by matter which is negatively charged and moving with great velocity, and on this hypothesis their mechanical properties, as well as the manner in which they become curved in a magnetic field, are readily explicable.

This latter hypothesis has suggested to me some experiments which I will now briefly describe, without for the moment pausing to inquire whether the hypothesis suffices to explain all the facts at present known, and whether it is the only hypothesis that can do so. Its adherents suppose that the kathode rays are negatively charged; so far as I know, this electrification has not been established, and I first attempted to determine whether it exists or not.

(2) For that purpose I had recourse to the laws of induction, by means of which it is possible to detect the introduction of electric charges into the interior of a closed electric conductor, and to measure them. I therefore caused the kathode rays to pass into a Faraday's cylinder. For this purpose I employed the vacuum tube represented in Fig. 1. A B C D is a tube with an opening a in the centre of the face B C. It is this tube which plays the part of a Faraday's cylinder. A metal thread soldered at S to the wall of the tube connects this cylinder with an electroscope.

E F G H is a second cylinder in permanent communication with the earth, and pierced by two small openings at β and γ; it protects the Faraday's cylinder from all external influence. Finally, at a distance of about 0·10 m. in front of F G, was placed an electrode N. The electrode N served as kathode; the anode was formed by the protecting cylinder E F G H; thus a pencil of kathode rays passed into the Faraday's cylinder. This cylinder invariably became charged with negative electricity.

The vacuum tube could be placed between the poles of an electro-magnet. When this was excited, the kathode rays, becoming deflected, no longer passed into the Faraday's cylinder, and this cylinder was then not charged; it, however, became charged immediately the electro-magnet ceased to be excited.

In short, the Faraday's cylinder became negatively charged when the kathode rays entered it, and only when they entered it; *the kathode rays are then charged with negative electricity.*

The quantity of electricity which these rays carry can be measured. I have not finished this investigation, but I shall give an idea of the order of magnitude of the charges obtained when I say that for one of my tubes, at a pressure of 20 microns of mercury, and for a single interruption of the primary of the coil, the Faraday's cylinder received a charge of electricity sufficient to raise a capacity of 600 C.G.S. units to 300 volts.

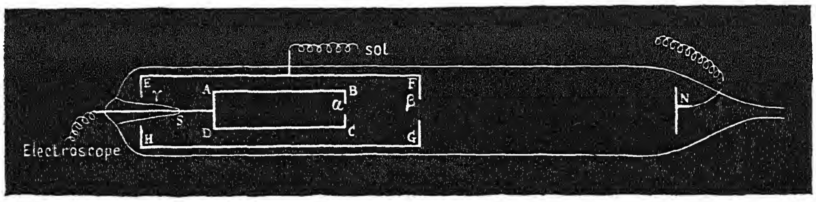


FIG. 1.

(3) The kathode rays being negatively charged, the principle of the conservation of electricity drives us to seek somewhere the corresponding positive charges. I believe that I have found them in the very region where the kathode rays are formed, and that I have established the fact that they travel in the opposite direction, and fall upon the kathode. In order to verify this hypothesis, it is sufficient to use a hollow kathode pierced with a small opening by which a portion of the attracted positive electricity might enter. This electricity could then act upon a Faraday's cylinder inside the kathode.

The protecting cylinder E F G H with its opening β fulfilled these conditions, and this time I therefore employed it as the kathode, the electrode N being the anode. The Faraday's cylinder is then invariably charged with *positive electricity*. The positive charges

[1] Translation of a paper by M. Jean Perrin, read before the Paris Academy of Sciences on December 30, 1895.

[2] These vibrations might be something different from light; recently M. Jaumann, whose hypotheses have since been criticised by M. H. Poincaré, supposed them to be longitudinal.

were of the order of magnitude of the negative charges previously obtained.

Thus, at the same time as negative electricity is *radiated* from the kathode, positive electricity travels towards that kathode.

I endeavoured to determine whether this positive flux formed a second system of rays absolutely symmetrical to the first.

(4) For that purpose I constructed a tube (Fig. 2) similar to the preceding, except that between the Faraday's cylinder and the opening β was placed a metal diaphragm pierced with an opening β', so that the positive electricity which entered by β could only affect the Faraday's cylinder if it also traversed the diaphragm β'. Then I repeated the preceding experiments.

When N was the kathode, the rays emitted from the kathode passed through the two openings β and β' without difficulty, and caused a strong divergence of the leaves of the electroscope. But when the protecting cylinder was the kathode, the positive flux, which, according to the preceding experiment, entered at β, did not succeed in separating the gold leaves except at very low pressures. When an electrometer was substituted for the electroscope, it was found that the action of the positive flux was real but very feeble, and increased as the pressure decreased. In a series of experiments at a pressure of 20 microns, it raised a capacity of 2000 C.G.S. units to 10

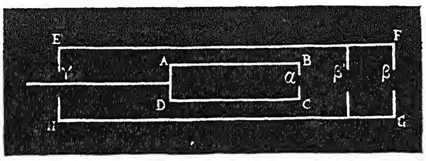


FIG. 2.

volts; and at a pressure of 3 microns, during the same time, it raised the potential to 60 volts.[1]

By means of a magnet this action could be entirely suppressed.

(5) These results as a whole do not appear capable of being easily reconciled with the theory which regards the kathode rays as an ultra-violet light. On the other hand, they agree well with the theory which regards them as a material radiation, and which, as it appears to me, might be thus enunciated.

In the neighbourhood of the kathode, the electric field is sufficiently intense to break into pieces (*into ions*) certain of the molecules of the residual gas. The negative ions move towards the region where the potential is increasing, acquire a considerable speed, and form the kathode rays; their electric charge, and consequently their mass (at the rate of one valence-gramme for 100,000 Coulombs) is easily measurable. The positive ions move in the opposite direction; they form a diffused brush, sensitive to the magnet, and not a radiation in the correct sense of the word.[2]

THE FRENCH MAGNETIC SURVEY OF THE WORLD.

IN Europe, as well as in the United States of America, the study of terrestrial magnetism has for some time played an important part.

M. le Commandant de Bernardières has written a most interesting account of the construction of new magnetic maps of the globe, undertaken by the Bureau des Longitudes. The following are a few facts given by him, which show to what extent it is contemplated to carry out the work.

From the magnetic determinations already obtained, some maps have been made; observatories too, permanent and otherwise, have been built. But the work is not entirely satisfactory. The maps are chiefly the result of observations made by navigators, and are only of limited parts scattered over the face of the earth.

In order to have a *general* magnetic map, numerous observations would have to be made, distributed over all regions, taken as nearly as possible at the same time, and in the same way with similar instruments. To this end the Bureau des Longitudes have appealed to Vice-Admiral Besnard, Minister of Marine, who has promised help, and put at their disposal officers and sailors, and also a great number of instruments. The Colonial Minister has also shown interest in the matter, and promised his assistance in the colonies.

Seven sets of observers have been organised, consisting each of a lieutenant, ensign or hydrographer, and one assistant. These expeditions have been arranged as follows:—

Atlantic Ocean	West Coast of Africa, East Coast of America, Antilles, &c.	M. Schwérer, lieutenant of the ship.
Pacific Ocean	West Coast of America	M. Blot, ensign of the ship.
Pacific Ocean	Oceana	M. Monaque, ensign of the ship.
Indian Ocean	Red Sea, South Coast of Asia, Oriental Coasts of Africa, Madagascar, and other islands	M. Paqué, ensign of the ship.
Chinese and Japanese Seas	Coasts of Indo-China, of China and Japan	M. Terrier, ensign of the ship.
—	Madeira, Canary Islands Azores, Cape Verd Islands, Senegambia	M. de Vanssay, hydrographic engineer.
Iceland	North Sea, Scandinavia, Denmark, Scotland	M. Houette, captain of the frigate, commanding the Iceland station; M. Morache, lieutenant of the ship.

With expeditions in these various parts of the earth, it will be possible to make observations almost simultaneously.

In order to determine the correct value of the magnetic elements, as well as to ascertain the exact variation of these elements, the missions have been supplied with the finest instruments, which have been adjusted at the observatories of Montsouris and Parc Saint-Maur; comparisons will also be made at every magnetic observatory at which they arrive during the expedition. Special instructions have been given with regard to calculations and method of observation, in order to insure a perfect comparison of results.

Six of these expeditions have started, and have communicated already the result of some of their first observations; the work, however, will have to be continued about two more years.

The ship *Manche*, which left France last spring, for Iceland, has returned with a great number of observations, obtained in Cherbourg, Scotland, the Shetland Isles, Iceland, Norway, and Denmark. In the observatory constructed by the *Manche* at Keykiawik, two complete observations of variations were obtained, having each a duration of eight days.

It will be very interesting to compare the results of the present day with those of the *Recherche*, obtained sixty years ago, and since then of several other expeditions. The successful return of the *Manche* certainly indicates that great things may be expected of the other expeditions, and makes it certain that a most important step has been taken by the French Government for the advancement of science.

[1] The breaking of the tube has temporarily prevented me from studying the phenomenon at lower pressures.

[2] This work has been carried out in the laboratory of the Normal School, and in that of M. Pellat at the Sorbonne.

LILIENTHAL'S EXPERIMENTS ON FLYING.

THERE are many of us, no doubt, who are watching with great interest the experiments of Herr Otto Lilienthal in his "Fliegesport and Fliegepraxis." These "Uebungen," which he is making from a hill thrown up in the neighbourhood of Berlin, have, from the very beginning, been rewarded with a distinct success; and it seems that, given time, he may present us, if not with a method of flying, then with an approximation to it, which perhaps at some later date may be more fully developed.

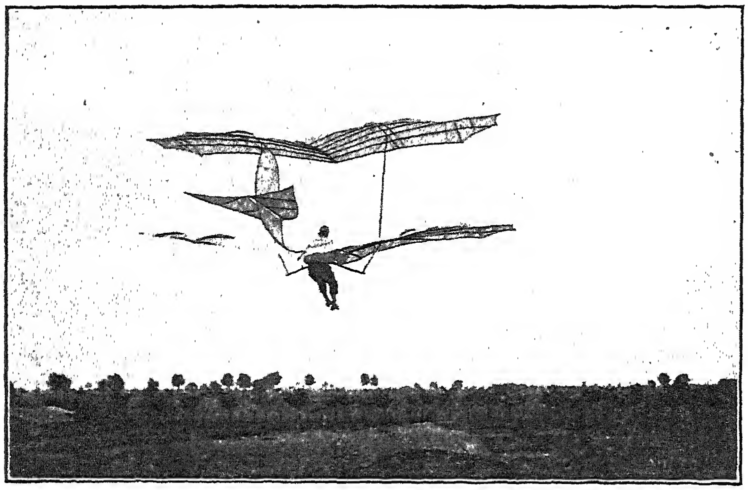


FIG. 1.

His experiments have, up to the present, shown that, by means of such an apparatus as he employs, fairly long flights may be indulged in with perfect safety, provided the operator does not attempt to do too much at the beginning, but contents himself with mastering the first elements of sustaining his equilibrium.

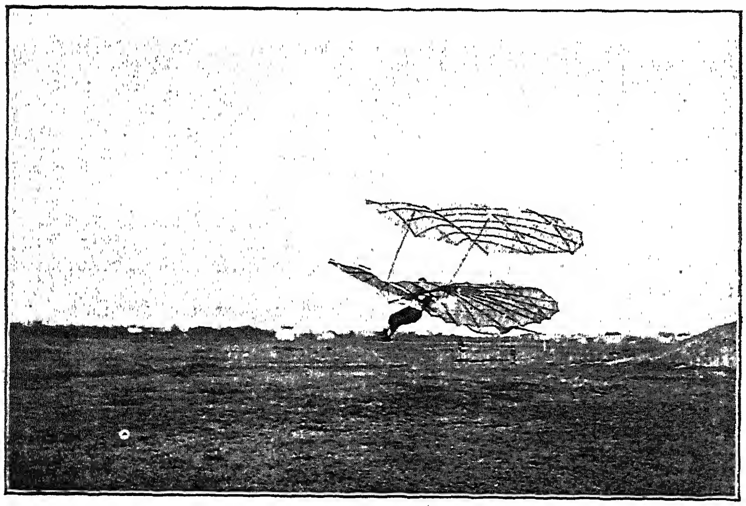


FIG. 2.

In a previous article (NATURE, vol. li. p. 177), a short account was given of Herr Lilienthal's earlier experiments on this subject, and it was then mentioned that falls must be expected in the preliminary trials, until the operator becomes accustomed to the many new conditions which make themselves apparent at every step, before they can be mastered instinctively.

Similar difficulties have, for instance, to be contended with when learning to ride a bicycle. The beginner is at first unable to keep his equilibrium, and so wobbles here and there with the loss of much power, until he eventually finds himself on the ground. This is simply because he is doing something unusual, and is not accustomed to the new conditions. An adept rider, on the other hand, never thinks of the possibility of falling, and quite unconsciously keeps his equilibrium without any exertion or loss of power on his part. So it is with this sailing machine, and it is only with practice that the required head can be obtained and success assured.

In the above-mentioned article, the machine Lilienthal employed consisted of a wing-shaped framework of a slightly curved nature, the advantage of the curved form, both as regards the amount and direction of the resistance, having been previously proved. The tail consisted also of two plane surfaces, one being at right angles to that of the horizontal framework, and lying in the direction of movement, and the other more generally in that horizontal plane, but capable of movement about a fixed point in it.

With the wind blowing at a moderate and more or less constant rate this machine has been found to be very satisfactory, and flights of comparatively long duration have been made with it.

Lilienthal's ambition, however (*Prometheus*, No. 322, p. 148), does not end here; but he looks further ahead than this, and wishes to be able to practise in such strong winds that he can be carried along with them. He, however, remarks that the size of the apparatus puts a certain limit to this; for if the spread of the wings be too large, then the whole arrangement becomes extremely awkward and hard to manage.

Up to the present, although he has practised in moderately rough weather, and had to perform fantastic feats in the air to keep his equilibrium, he has been fortunate in obtaining on nearly every occasion a safe landing. Experience has, however, convinced him that before trying to compete against strong winds in future, he must modify his machine to some extent, in order to make it easier to handle under these more trying circumstances.

To this end experiments were made with wings of various shapes; but these were given up, as it was found that the employment of a new principle, suddenly discovered, gave the required results with satisfaction that was scarcely dreamt of. The idea consisted in using, instead of one large framework covered with some light material, two smaller ones, placed parallel one above the other. These, of course, would, when sailing through the air, have a similar lifting effect; but, besides affording a simple means of increasing the sail-

area without adding to the breadth of the machine, they would decrease very considerably the difficulties, referred to above, with respect to the management of the centre of gravity.

On this principle, Otto Lilienthal constructed his new double-apparatus (Fig. 1), the appearance of which will be noticed from the accompanying illustrations. Each separate surface has an area of nine square metres; thus he is able to employ the very large carrying surface of eighteen square metres with a breadth of only five and a half metres. The upper surface, which is placed at a distance of about three-quarters of a wing-breadth above the lower, proves in no way a disturbing factor in the machine, as might at first be supposed, but develops simply a vertical lifting force. It may be remarked that this double-surface machine is managed in exactly the same way as the single-framed one.

From Fig. 2 it is easy to obtain a good idea of the arrangement adopted, by which the upper surface is fixed rigidly to the lower one by means of two rigid stays, the whole surface being held in position by means of thin wires.

With this new apparatus, Otto Lilienthal has already found that a step in the right direction has been made. The energetic movement of the centre of gravity, and the consequent more safe management of the apparatus, has led him to practise in winds blowing at times over ten metres per second. "These experiments," he says, "have given the most interesting results that I have arrived at since I began." With a wind velocity of six to seven metres per second, the sailing surface of eighteen square metres carried him against the wind in nearly a horizontal direction from the top of the hill, without even having to run at the start, as is generally necessary. More interesting still, is it to learn that, with stronger winds, he allows himself to be simply lifted by the wind from the hill-top, and sail slowly against it. Fig. 3 is such a case in point. The same illustration also shows how strong at times may be the side-motion, the operator having to considerably alter the position of his centre of gravity to retain his equilibrium.

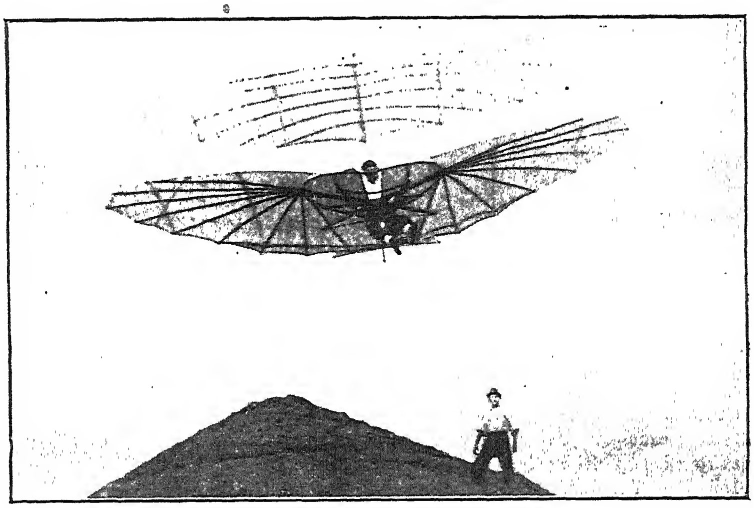


FIG. 3.

As experiments have shown, the sailing path is directed strongly upwards by increasing wind force, and this fact causes him sometimes to be higher in the air than he was at his original starting-point. In this position his apparatus has occasionally come to a standstill; and this leads him to make the following interesting statement: "At these times I feel very certain that, if I leaned a little to one side, and so described a circle, and further partook of the motion of the lifting air around me, I should sustain my position. The wind itself tends to direct this motion; but then it must be remembered that my chief object in the air is to overcome this tendency of turning to the left or right, because I know that behind and under me lies the hill from which I have started, and with which I would come in rough contact if I allowed myself to attempt this circle sailing. I have, however, made up my mind, by means of either a stronger wind or by flapping the wings, to get higher up and further away from the hill, so that, sailing round in circles, I can follow the strong uplifting currents, and have sufficient air space under and about me to complete with safety a circle, and, lastly, to come up against the wind again to land."

It may be remembered that Lilienthal has previously employed some mechanical aid, such as the flapping of the wings: an illustration of the apparatus so arranged was given in the article already referred to above (NATURE, vol. li. p. 178). Perhaps he will apply the same arrangement to the lower framework of his present apparatus, and thus accomplish the end he is wishing to attain.

One can quite understand that sailing against the wind is one thing, and with it another. In the latter case, since the framework is inclined slightly upwards in the direction of motion, the wind would meet the sailing surface from above and shoot the operator, arrow-like, to the ground if he were unable to come up again quick enough to the wind. That such circle sailing will be most probably successfully accomplished by Herr Lilienthal seems certain, but the first few attempts may prove, perhaps, rather rough.

The recent experience of Otto Lilienthal has thus shown that by means of his new apparatus a very close approximation to flying has been attained.

Should he, however, find that the accomplishment of circling is not attended by any great difficulty, and there appears no reason why it should, then there seems no doubt that an important step will have been made, and the future development of this *Fliegesport* will depend nearly directly on the *Fliegepraxis*.

It is interesting to notice that in America this Lilienthal-method is about to be tested. We have in the British Isles already a follower in Percy S. Pilcher, of Glasgow University, but his experiments at Cardross, in Dumbartonshire, have not as yet proved very successful, owing to the wings of his apparatus being too much inclined. He is, however, busy with the construction of a new machine, which will have a sail-area of 300 square feet (= 27·6 square metres). The experience of Lilienthal has shown, however, that with such a large expanse this machine will only be able to be used in moderate winds with safety. If its construction be not already too far advanced, it would seem advisable to add the second or upper surface, since its presence has been shown to be attended by greater stability and easier management of the whole apparatus.

W. J. S. L

DEATH OF MR. ALEXANDER MACMILLAN.

WE much regret to record the death of Mr. Alexander Macmillan, one of the founders of this journal. This is not the place to give a long account of his career. We may limit ourselves to the statement that outside the field of scientific workers there were few who possessed a greater sympathy with scientific aims, few who had a keener insight as to the place science should occupy in our national life and in our educational systems. It was the hope that a more favourable condition for the progress of science might be thereby secured that led him to enter warmly into the establishment of this journal in 1869. Mr. Macmillan was born in 1818, and died on Saturday last, at his residence in Portland Place.

NOTES.

M. MAURICE LŒWY, the distinguished French astronomer, has been elected a corresponding member of the Berlin Academy of Sciences.

ELON COLLEGE, of North Carolina, has received an endowment of 100,000 dollars from a resident of New York City. The faculty will not reveal his name.

MME. W. HUBER has presented a sum of 20,000 francs to the Paris Geographical Society, in remembrance of her husband. The Society has made the donor a life member, and has devoted the money to establish, under the name "Prix William Huber," a silver medal to be awarded annually to the author of the best work on the structure of mountains and valleys, or on glaciers and mountain lakes.

ACCORDING to the New York *Nation*, Portugal is about to follow the example of some greater Powers, and celebrate a quater-centenary of its own. At the request of the Geographical Society of Lisbon, the Government has just determined to celebrate, with much pomp, in 1897, the four-hundredth anniversary of the expedition which, on July 8, 1497, set out, under the command of Vasco da Gama, for the discovery of the route to India round the Cape of Good Hope. Few details of the celebration have as yet been settled upon, but it is expected that special expositions will be opened at Lisbon, and many scientific congresses held, to which the world will be invited.

WE have already referred to some of the honours given in commemoration of the centenary of the French Institute. How freely France distributes her decorations to men of science will be seen from the following list, given in the *Revue Générale des Sciences*, of the recent nominations to, and promotions in, the Order of the Legion of Honour. Grand Officer: M. J. Bertrand, Secrétaire Perpétuel of the Academy of Sciences. Commanders: MM. C. J. Bouchard, P. E. Duclaux, M. Lœwy, E. J. Marey, Members of the Academy of Sciences. Officers: MM. P. Appell, A. d'Arsonval, F. A. Fouqué, A. Gautier, E. Grimaux, H. Léauté, H. Moissan, E. Perrier, Members of the Academy of Sciences, and MM. A. Houzeau, R. Lépine, F. Raoult and E. Stephan, Correspondants of the same Academy. Chevaliers: MM. R. Blondlot, l'abbé A. David and G. E. Sire, Correspondants of the Academy of Sciences; and MM. Chappuis and Guillaume, of the Bureau international des Poids et Mesures.

WE have on several occasions called attention to the blunders which are made, and the disputes in which the country is involved from time to time, because of the unintelligent way in which the work of various Government departments is carried on. Each branch of the public service, instead of being advised by a scientific staff, is controlled by an officialdom which believes in its own omniscience; a condition of things as deplorable as it is derogatory to national honour and advancement. As we have before pointed out, administrators of departments in which questions involving scientific knowledge continuously arise are, to put the point mildly, *not* chosen on account of their scientific qualifications, and they have to pick up their information as best they can, the result being that they arrive at unsound decisions, and create dissatisfaction everywhere. The *Engineer* of January 17 has something to say which strongly supports our complaint of the neglect of scientific knowledge in the public service. Referring to Admiralty contracts, our contemporary says: "The duty of the Admiralty is to obtain the best possible ships, engines, guns, &c., that can be had; and that those who have to consider the tenders ought to know when a tender is too high or too low. In a word, they ought to know the value of what they propose to buy. Whether the knowledge does or does not exist in the Controller's department, we are unable to say; apparently it does not. The actual method of obtaining ships is strictly analogous to that adopted by a man who, totally ignorant of what a dwelling-house ought to cost, first gets drawings from an architect, and then advertises for tenders. Having obtained them, he proceeds to pit the tenderers against each other, assuming that in this way he will get the best value for his money. The mere mention of this method of doing business will be enough to condemn it in the eyes of our readers. But there is ample evidence available that the Whitehall people do not know what is the proper price to pay for work or materials, and to this ignorance on the one hand, and on the other to a fear of being cheated based on that ignorance, is no doubt due the bargaining and bartering which, during the last few years, have gone on at Whitehall, and have at last become so vexatious that it is matter of common talk among those firms who have laid themselves out to execute Admiralty orders." It is clear that if the relations between the Admiralty and the shipbuilding and engineering firms of the country are to be of a cordial description, the present system of conducting business will have to be greatly altered, and the sooner the alteration comes the better it will be for the country's welfare.

MR. F. E. WILLEY, of the Royal Gardens, Kew, has been appointed Curator of the newly-founded Botanic Station at Sierra Leone. Mr. J. M. Henry has retired from the post of Superintendent of the Baroda State Gardens. He was sent out from Kew in 1867, and after twelve years' service in Madras and Bengal was appointed to Baroda in November 1879.

DR. JOHN S. BILLINGS, Director of the Department of Hygiene in the Pennsylvania University, has been elected librarian of the new consolidated libraries of New York, representing the Lennox library, the Astor library, and the Tilden bequest. Dr. Billing's Index Medicus, and the Index Catalogue of the Surgeon-General's Library at Washington, furnish stupendous evidence of his capacity for cataloguing, and, with his experience in other directions, make him eminently fitted for the responsible post he has taken.

MR. A. G. CHARLETON presided on Friday, the 24th inst., at the Criterion Restaurant, over the twenty-third annual dinner of the old students of the Royal School of Mines. About a hundred and twenty guests were present, amongst these being the professors at the School and several distinguished visitors. In proposing the toast of "The Mining and Metallurgical Indus-

tries," the Chairman commented upon the relation of peace and monetary matters, and showed how the School of Mines was of the highest importance in training men to open up gold and other mining centres. Profs. Roberts-Austen and Le Neve Foster replied for metallurgy and mining, respectively. The toast of "The Professors" was proposed by Prof. Page, and replied to by Prof. Judd. Mr. G. T. Holloway proposed "The Learned Societies," and Prof. Tilden responded. "The Health of the Old Students" was dealt with by Mr. B. H. Brough and Mr. S. H. Cox. The question of the formation of a register of the old students was referred to by several of the speakers, and a guarantee fund for its publication was raised.

A NOTE received from Mr. John Plummer, Sydney, New South Wales, calls attention to the way in which science is represented in the colony. The Royal Society of New South Wales originated in 1821 as the Philosophical Society of Australasia, the present name being adopted, by Royal sanction, in 1856. The Linnean Society of New South Wales was established mainly by the efforts of the late Sir William Macleay, a devoted naturalist, in 1875, and has numbered among its members many of the leading scientific men in Australasia. The Royal Geographical Association, established in 1883, has branches in Victoria, South Australia, and Queensland. The headquarters of the Australasian Association for the Advancement of Science, based on the lines of the British Association, are in Sydney. The meetings of the Association are held alternately in the various colonies. Among other scientific associations in Sydney are the New South Wales Zoological Society, branches of the British Astronomical and British Medical Associations, Australian Economical Association, Pharmaceutical Society, Engineering Association, Insurance Institute, Institute of Architects, Institute of Bankers, Electric Club, Institute of Surveyors, &c.; not a bad record for a country which has but recently completed the first century of its existence, and is yet practically in its infancy as a nation.

A HYGIENIC EXHIBITION will be held at Warsaw during the present year. The *Journal* of the Society of Arts says that there are nine Committees at work, to whom have been assigned the following subjects: (1) Air, water, light; food in general, and articles connected with the above; also kitchen utensils, paints, wall-paper, and poisonous vegetables. (2) The question of sterilisation; also the utensils used for the culture of bacilli, showing exhaustively the method of ascertaining their presence and the means for their destruction. (3) Human dwellings in general, past and present, and the latest improvement in hygienic building. (4) The hygienic mode of caring for children; construction of school-houses, all systems of school education, and school-rooms and furniture. (5) The hygiene of industry; the hygienic conditions prevailing in the homes of labourers, shops, and factories; also food, and drink, and vital statistics. (6) The history and statistics of hygiene and the modern hospitals of the world. (7) The literature and history of pharmacy, patent medicines, furniture, and medical instruments, and all pharmaceutical utensils. (8) Statistical plans, diagrams, drawings, and all printed matter on the subject of hygiene, meteorology, geology, hydrography, and anthropology, in all their detail, and all sciences connected therewith. (9) The manner of living, dwellings, &c., of all classes of the population from a sanitary point of view. Awards of gold, silver, and bronze medals will be made, and also diplomas and letters of honour.

THE French Meteorological Office has recently issued its *Annales* for the year 1893, consisting of three parts: (1) memoirs, containing discussions on thunderstorms, distribution of hail, terrestrial magnetism, &c.; (2) observations made at stations in France and its colonies; and (3) a very detailed account of the distribution of rainfall. From the introductory text we see that weather forecasts are regularly issued to seaports and to agriculturists, and also warnings of storms. In both of these departments a large amount of success has been achieved, part of which is attributed to the regular receipt of telegrams from the Azores and from America, a comparison of these data allowing a more accurate idea to be formed of the changes which approach from the Atlantic Ocean. Observations are regularly collected from ships, and the observers, both on land and at sea, are encouraged in their work by the presentation of medals to those who have kept the best registers. Comparative observations are made at the Central Office and on the Eiffel Tower; the next year will complete a series of five years' observations, when a discussion of the more important results obtained will be undertaken, with especial reference to the influence of altitude on the various meteorological elements.

A SIMPLE instrument for recording the time of occurrence of an earthquake is described by Prof. C. F. Marvin in the *U.S. Monthly Weather Review*. A heavy lead weight is suspended on a short steel link, to which it is pivoted by means of a sharp-pointed screw, the point being just above the centre of gravity of the weight. A similar pointed support is provided for the top of the link, which hangs from a small projection in the frame of the instrument. The link is prolonged upwards as a needle about 6 inches long, the top of which passes through a small hole in a plate connected with the frame. The plate is electrically insulated from the rest of the instrument. A movement of the ground is magnified by the end of the needle, and the contact of the needle with the sides of the hole in the plate can, by connection with suitable electrical apparatus, be made to stop a clock or produce an automatic record on a sheet of paper. The instrument is a modification of one devised by Prof. Marvin in 1885, and has been in operation at the U.S. Weather Bureau since the winter of 1892–93. The recording apparatus used with it is the so-called "weekly anemometer register," and the time of a disturbance can be read to less than half a minute. It will be seen from this brief description that Prof. Marvin's seismoscope is almost identical with that used to start the revolving plate in Prof. Ewing's well-known seismograph.

THE first number of *The Scalpel* contains an article, by Mr. Lennox-Browne, on the new serum treatment of diphtheria, in which the writer comments upon the statistics derived from its application here and on the continent respectively, and attempts to explain the great discrepancy which so far exists between British and foreign results. Without entering into all the details of the controversy, there is one point which may be of some significance in the discussion; and this is the complaint made to the Clinical Society, that with the English serum supplied, no indication was given of the varying strength with which it was endowed. It may be of interest to know that in Germany the antitoxic serum is subject to State control as regards its preparation, the estimation of its activity, and its sterility, and that each phial which is issued, bears as a guarantee the official control number, as well as the date of the official test of the serum. The fact that in England such striking results have not so far been obtained as on the continent and in America, cannot alter the fact that we have undoubtedly in the serum-treatment of diphtheria a new departure in therapeutics, the far-reaching importance of which can hardly be exaggerated, and certainly not denied.

THE number of icebergs met between the Cape of Good Hope and Australia are vastly greater in some years than in others. Within the past few years, for instance, an extraordinary accession of enormous icebergs has occurred. As an explanation of this, it has been suggested that unusual falls

of snow may account for it by accelerating the motion of the ice; but Mr. H. C. Russell, F.R.S., remarks, in a paper read before the Royal Society of New South Wales in September last, that the circumstances forbid the acceptance of this view, because the motion of the glacier depends mainly on the declivity down which it is descending, and that does not alter, and the piling up of snow could not in one year cause such a marked increase in the rate of flow as would be necessary to account for the enormous increase in number of icebergs which appear from time to time. There must evidently be a force sufficient to break off the icebergs which are slowly forming on shore, and to do it at irregular periods separated by many years. He is of the opinion that the true cause resides in the volcanoes of the Antarctic continent, when they burst forth in eruption, and by the act so shake the foreshores, that the icebergs are broken off from the glaciers. In connection with Mr. Russell's paper, it is interesting to note a report, issued from the U.S. Hydrographic Office, descriptive of the floating ice seen during 1892 and 1893 in the South Atlantic east of Cape Horn. It is said that the icebergs were of such size that they could not have been formed on small, low-lying islands, but only on a large continent of such height that great glaciers could be formed.

Is there a connection between crime and the weather? The relations between certain meteorological conditions and many diseases has been fairly well established, and more knowledge about the connection is likely to be obtained now that a department having for its object the collection of statistics referring to climate and health has been formed in the U.S. Weather Bureau. And if bodily disease is affected by atmospheric changes, why not those mental diseases which result in the perpetration of crimes? Several attempts have been made to reveal a connection between the moods and impulses of the people and the weather, and a description of the results obtained in the latest of these investigations is contained in the current number of the *American Meteorological Journal*. The investigator is Mr. C. E. Linney, Director of the Illinois State Weather Service, who has considered the police records of the city of Chicago for each month in the years 1888–1894, the total number of arrests for each month, and for each division of crime, being examined with his "weather eye" open. While it is admitted that there are some cases which seem to go against the general rule, Mr. Linney thinks that the results do show a marked increase in crime with the increase in temperature, probably daily, at least for the months, seasons, and the year. Also that there is an increase in crime with a marked deficiency in rainfall, temperature conditions remaining normal; and again a greater increase where both conditions are aggravating causes. As for humidity, there seems to be no special connection, and also little connection with the cloudiness, except possibly a slight increase in clear, and a slight decrease in cloudy, weather. On the other hand, it is thought that the figures show a decrease in crime with a deficiency in temperature, especially during winter months, or with excess in rainfall in summer, and a greater decrease when both are restraining causes. Mr. Linney also thinks his results indicate that there is a decrease in crime with a north-east over a south-west wind. Perhaps the day will come when police stations will possess a full equipment of meteorological instruments, by reference to the readings of which police inspectors will regulate their vigilance.

NOS. 5 and 6 of the "Records of the Botanical Survey of India" are devoted to a report on a botanical tour in the Lakhimpur District, Assam, by Mr. G. A. Gammie; and notes on a journey from Poona to Nagotna, by Mr. G. M. Woodrow.

WE have received a copy of the memoir of the late Mr. Frederic Kitton, the well-known diatomist. His life affords one of the numerous instances of the great additions to our scientific knowledge due to men immersed in business, who can only devote to science their hard-earned leisure.

A CATALOGUE just received from the General Electric Company shows to what a vast extent the electrical industry has grown. The catalogue, which runs into nearly one thousand quarto pages, appears to include illustrations and descriptions of almost every invention known in connection with the application of electricity to useful purposes, and an abundance of information of value to electricians, while students will obtain from it a good idea of modern electrical work.

NOS. 4 AND 5 (vol. iii.) of the "Contributions from the United States National Herbarium," issued by the Department of Agriculture, have reached us. The former is devoted to a report, by Mr. J. M. Holzinger, on a collection of plants made by Mr. J. H. Sandberg and assistants in Northern Idaho in the year 1892. The latter contains a report, by Prof. J. M. Coulter and Mr. J. N. Rose, on Mexican Umbelliferæ, mostly from the State of Oaxaca, collected by Mr. C. C. Pringle and Mr. E. W. Nelson; and descriptions of plants, mostly new, from Mexico and the United States, by Mr. J. N. Rose.

MR. ARTHUR LISTER, the monographist of the Mycetozoa, who recently presented to the British Museum a magnificent collection of these organisms, together with a number of microscopic slides, has now prepared a "Guide to the British Mycetozoa," founded on these collections, which can be obtained in the Botanical Gallery of the Museum. It contains a most valuable, though concise, account of the life-history of these interesting structures, and a synopsis of the British genera and species. Each genus is illustrated by at least one woodblock drawn by the pencil of Miss Galielma Lister.

A "Review of Mineral Production in India" for 1894, compiled by Mr. G. Watt, has been published by the Indian Government. It is carefully prepared, and as regards the important materials salt, coal, and petroleum, the statistical returns of production, import and export, are complete. Iron ore is also fully treated; but it was not found possible to give complete statements of other minerals, though a great deal o information, both statistical and descriptive, has been brought together. In view of the great difficulties in the way of obtaining full information, the result is very satisfactory, and will probably lead to greatly improved reports in the future.

WITH the January number, the *National Geographic Magazine*, published by the National Geographic Society, Washington, commences a new series, and makes its first appearance as a monthly publication. It is intended that the magazine shall be the exponent of the geography—physical, political, and commercial—of the New World; in fact, the aim is to be American rather than cosmopolitan. The articles in the first number are "Russia in Europe," by the Hon. Gardiner G. Hubbard; "The Arctic Cruise of the U.S. Revenue Cutter *Bear*" (with illustrations), by Dr. Sheldon Jackson; and "The Scope and Value of Arctic Exploration," by General A. W. Greely.

THE eleventh volume of "Travaux et Mémoires" of the International Committee of Weights and Measures, has just come to us from MM. Gauthier-Villars, together with a volume containing the "Procés-verbaux" of the meetings of the Committee in 1894. Under the title, "Determination expérimentale de la valeur du mètre en longueurs d'ondes lumineuses," the former contains a detailed account of Prof. Michelson's work in connection with the use of the light-wave as the ultimate standard of length. There are two other papers in the volume, viz. "Mètres prototypes et étalons," by M. J. René Benoît and

M. C. E. Guillaume, and "Nouvelles déterminations des mètres étalons du Bureau international," by the same authors.

WE have received the 22nd and 23rd Annual Reports of the Geological and Natural History Survey of Minnesota (for 1893 and 1894). Among the contents of the latter are a criticism on the late Dr. G. H. Williams's explanation of the Archæan greenstones, by N. H. Winchell; a preliminary report on the gold region of Rainy Lake, by H. V. Winchell and U. S. Grant; an historical sketch of Lake Superior mining, by H. V. Winchell; and a study of the late Glacial earth-movements of the St. Lawrence basin, by Warren Upham. Geologists will be interested to know of the issue of an official "List of Publications" of the Geological Survey of Canada (Ottawa: 1895), which includes all reports, with their separate contents, maps, and certain papers on Canadian geology, reprinted from various publications.

THE ninth annual report of the Liverpool Marine Biology Committee contains an account of much useful work done at the Port Erin Station during the past year. (1) In his consideration of the submarine deposits of the Irish Sea, Prof. Herdman suggests the recognition of a neritic group of deposits in addition to the pelagic and terrigenous deposits defined by Murray. The neritic deposits are largely organic in origin, formed from the remains of plants and animals living on the bottom, and so differ on the one hand from the terrigenous deposits derived from the waste of land, and on the other from the deep-sea varieties due chiefly to the accumulation of the remains of pelagic organisms. (2) So far as experiments with drift-bottles have been able to show, the prevailing currents on the west of the Isle of Man seem to be towards the Irish coast, and on the east towards the Lancashire, Cheshire, and Cumberland coasts; these observations are interesting on account of the existence of flat-fish spawning grounds in the neighbourhood of the Manx coast. (3) The report also furnishes additional evidence in favour of the Darwinian view that closely-related species are not, as a rule, found together. In addition to the investigations on these general problems, the report includes various contributions in regard to the local fauna.

THE 1896 edition of that very comprehensive volume, the "Annuaire du Bureau des Longitudes," has now been issued. To say that no year-book is of greater service to astronomers and physicists than this "Annuaire," is but to record the opinion of all workers in the domain of physical science. The present edition has been brought thoroughly into line with recent knowledge. M. Lœwy has added a brief note on the proper motion of the sun, and the apex of the sun's way. M. Cornu contributes two new notes—one on the bright lines in the spectrum of the chromosphere recently identified with those of terrestrial substances, and the other on the identification of lines in stellar spectra. The list of minor planets has been brought up to 416; and some changes have been made in the list of double-star orbits. M. Moureaux gives the values of the magnetic elements determined at 644 points in France; and M. Cornu contributes new chapters on specific heats, and on the latent heats of fusion and vaporisation of water. Among the articles, we notice one on action at a distance and waves, and another on Fresnel's works, both by M. Cornu; and there is also an article on the proposed magnetic survey of the earth, by Captain de Bernardières; and an account, by M. Janssen, of his third ascent to the observatory on the top of Mont Blanc.

MESSRS. DULAU AND CO. have made arrangements to publish a work on "The Coccidæ of Ceylon," by Mr. E. E. Green. All the species at present recognised in Ceylon, including several new genera and numerous new species, will be described, and illustrated by 120 coloured plates. The work will be published in four parts, for which Messrs. Dulau are now inviting subscriptions. In the prospectus announcing the proposed publication is an inset, in which the opinion of members of the B.A. committee on the Coccidæ of Ceylon is set forth. It is there pointed out that what is known of the distribution of this cosmopolitan group justifies the belief that many of the new species from Ceylon described by Mr. Green will prove, as inquiry advances, to be world-wide. The Committee therefore recommend the work to the consideration of subscribers, believing that it "will be of great assistance to gardeners and to naturalists generally, and of considerable value to those engaged in economic entomology or in the management of plantations in any part of the world, as well as to systematic entomologists and morphologists."

SEVERAL new editions of scientific works have lately been received. Messrs. E. and F. N. Spon have published the third edition of Prof. J. H. Cotterill's classic volume on "The Steam Engine considered as a Thermodynamic Machine." A few slight changes and additions have been made in the appendix, but the book has been practically reprinted without substantial alteration. The eleventh edition of "Discoveries and Inventions of the Nineteenth Century," by Mr. Robert Routledge, has been published by Messrs. G. Routledge and Sons. The text has been emended. and the volume has been enlarged by a few pages of notes, and by new sections dealing with some of the engineering achievements and scientific discoveries of the last five years. The final part (vol. iii. part iv.) of the tenth edition of "Quain's Elements of Anatomy" (Longmans, Green, and Co.), edited by Profs. Schäfer and Thane, has now appeared. Its subject is Splanchnology; the anatomical descriptions belonging to which have been revised, and in many cases rewritten, by Dr. J. Symington, while the histological portion has been re-edited by Prof. Schäfer. It is proposed to issue a chapter on superficial anatomy, in the form of an appendix to the work. The fourth edition has been issued of Mr. W. T. Lynn's slender book on "Remarkable Comets." From the useful list of the dates of the returns of interesting comets, we see that, in the spring of this year, Faye's comet (period 7½ years) is due, and in the spring or summer, Brook's comet (period 7 years). All the information in the book has been carefully brought up to date.

THE additions to the Zoological Society's Gardens during the past week include a Black-faced Kangaroo (*Macropus melanops*, ♀) from Australia, presented by Mr. E. Mitchell; a Himalayan Bear (*Ursus tibetanus*, ♀) from Upper Burmah, presented by Captain Gale; a Slow Loris (*Nycticebus tardigradus*) from Upper Burmah, presented by Captain J. W. Carrothers; a Salt-water Terrapin (*Clemmys terrapin*) from the West Indies, presented by Mr. J. Lea Smith; Seven Galliot's Lizards (*Lacerta galloti*), a Delalande's Gecko (*Tarentola delalandii*) from Madeira and Tenerife, presented by Mr. H. B. Hewetson, two Indian Jerboas (*Alactaga indica*) from Baluchistan, purchased.

OUR ASTRONOMICAL COLUMN.

THE DOUBLE STAR 70 OPHIUCHI.—Of the numerous orbits which have been computed for this well-known double star, that derived by Dr. Schur in 1893 is perhaps entitled to greatest confidence. Nevertheless, even in the short interval which has since elapsed, Dr. See finds that the companion is several degrees in advance of the theoretical position based on Schur's orbit. In explanation of this, as well as of other departures from the orbit which appear on close investigation, Dr. See suggests that the companion is attended by a dark satellite, moving in a retrograde direction with a period of about thirty-six years, the period of the visible pair being a little less than ninety years. The distance of the companion from the centre of gravity of itself and satellite is probably about $0''\cdot 3$; and a circular orbit with node and inclination identical with the similar elements of the visible pair sufficiently explains the observed changes of position angle and distance. Adopting the parallax $0''\cdot 2$, the

semi-axis major of the primary orbit is 22·74 astronomical units, while that of the secondary orbit is 1·5 astronomical units, and the combined mass is 1·6 times that of the sun. The whole system of 70 Ophiuchi is thus contained in a space less than that occupied by the solar system; the orbit of the bright companion being intermediate in size between those of Uranus and Neptune, while the action of the dark satellite causes it to describe a secondary orbit corresponding in size with that of Mars (*Astronomical Journal*, No. 363).

MINOR PLANET PHOTOGRAPHY.—The great value of the photographic method of recording the positions of known minor planets, and in searching for new ones, is admirably illustrated by the results obtained by M. Charlois (*Bulletin Astronomique*, January). Between November 18, 1894, and August 29, 1895, forty-one plates were exposed by him at the Nice Observatory on suitable parts of the sky, and only nine of these failed to show traces of the objects sought. In the remaining photographs forty-four known planets and eleven new ones were recognised. Four of the new ones were of the 11th magnitude, three of the 12th, one of the 13th, and three of the 14th, while eleven of the old planets were of 10th magnitude or brighter. The newly-discovered planets are thus among the smallest of this class of bodies. Up to the end of last year the patience of M. Charlois had been rewarded by the discovery of eighty-three minor planets, or a little more than one-fifth of the total number at present known.

THEORY OF COMETS' TAILS.—It has long been imagined that the phenomena of comets' tails are in some way due to a solar electrical repulsion, and additional light is thrown on the subject by recent physical researches. Several investigators have shown that when ultra-violet light falls on an uncharged body the surface disintegrates, the particles which fly off being charged negatively, while the body itself becomes positively charged. Applying this to the case of a comet, Prof. Fessenden suggests that negatively charged particles are emitted from that side of a comet which is turned towards the sun, while the nucleus has a positive charge (*Astrophysical Journal*, vol. iii. No. 1). According to J. J. Thomson's experiments, the fact that the C line of hydrogen is brighter than the F line indicates that the sun's chromosphere is negatively electrified, and hence the disintegrated particles of the comet will be subjected to four forces; namely, the force due to gravitation, a second force to the repulsion of the negative charge on the sun, a third due to the attraction of the positively charged nucleus, and a fourth due to the repulsion of all the other similarly electrified particles. The shape of the tail is the resultant effect of these four forces. The observed effects do not demand an improbably great solar potential, the value calculated being 15,000 volts. Accepting the theory, the contraction of the head, the partition of comets, multiple tails, and other appearances seem to find a reasonable explanation. The increasing positive charge of the nucleus as the sun is approached will result in an increased solar electrical attraction, and the effect will be the same as that which would be produced by a resisting medium; that is, the period will be shortened, as in the case of Encke's comet.

The fact that the most frequently observed spectrum of a comet's tail is like that of a candle flame, indicates, according to J. J. Thomson's experiments, that the particles of carbon are negatively electrified, and this is quoted in favour of the theory. It may be pointed out, however, that there is no such direct evidence to show that the nucleus is positively charged, as required by the theory.

THE ROTATION PERIOD OF VENUS.—A valuable contribution to the study of the rotation period of Venus has been made by Prof. Tacchini (*Atti Reale Acad. Lincei*, vol. v. p. 3). Observations made at the Collegio Romano during last summer, tended in favour of Schiaparelli's view that the rotation period of the planet is 224·7 days, that is, equal to the sidereal revolution. He now announces that continued observations, made under the best atmospheric conditions towards the end of 1895, have led to the same conclusion. The observations terminated on December 19, and on some occasions they extended over very considerable intervals on the same mornings. On November 28, for example, work was commenced at 5.45 and continued until 11 o'clock, and during this time the same features were constantly observed on the illuminated part of the planet. A nebulous arc on the dark part of the planet, near the southern cusp, observed in September last, was not seen in the recent observations.

THE INTERNATIONAL GEODETIC CONGRESS AT BERLIN.

LAST month, in the new Reichstag palace, in Berlin, the official international Congress of Geodesy met together. The members represented seventeen States of Europe, Asia, and America.

At this conference the delegates of France were: MM. H. Faye, Vice-President of the Bureau des Longitudes; Tisserand, Director of the Paris Observatory; Bouquet de la Grye, the retired Engineering Hydrographer in charge of the Marine; Bassot, Superintendent of the Geodetic Section of the Geographical Service of the Army; and Ch. Lallemand, Director of the General Levelling of France.

The Congress was welcomed, in the name of the Prussian Government by Dr. Bosse, Minister of Public Instruction. After recalling the fact that the International Geodetic Association was founded by the Prussian General Baeyer, Dr. Bosse briefly sketched the history of progress made in the different sections of geodesy during the last ten years, under the happy influence of the Association.

In reply to the Minister, M. Faye, President of the Association, very appropriately remarked that although Germany has done much for geodesy in the last fifty years, still France has the honour of having, during the last century, set the example.

Following this Prof. Foerster, Director of the Berlin Observatory (President of the Congress), described the recent discovery of the variation of latitude.

M. Fergola (Director of the Naples Observatory) has proposed since 1883 that observations should be organised in a permanent manner in observatories equally distributed round the earth, and situated at more or less the same latitude, in order to observe the small possible movements of the terrestrial axes. The first signs of these movements, noticed by M. Küstner at the Berlin Observatory, were reported to the Conference held at Salzburg in 1888 by the International Geodetic Association. The Association took up the question, and instituted two years afterwards an astronomical station of observations at Honolulu (Sandwich Isles), to control the results made in Europe. The success of this undertaking has now led the permanent commission of the Association to propose the realisation of M. Fergola's plan. This realisation will be greatly facilitated by the recent construction of a special photographic telescope, of which the first results were very interesting.

We will confine ourselves to naming some of the principal scientific communications made to the Congress. M. de Kalmar (Austrian delegate, and reporter on accurate levelling) announced the fact that, in the last three years, the total length of these levellings in Europe has increased from 20,000 kilometres, and exceeds to-day 120,000 kilometres. Colonel Bassot reported that three geodetic bases have just been measured in Roumania with the instruments of the Geographical Service, and with the help of French officers. Another base must be measured next in Turkey under the same conditions. M. Bouquet de la Grye announced that the Bureau des Longitudes have just undertaken, with the help of the officers of the French Marine, the execution of a new magnetic map of the world. M. Lallemand reported, amongst the principal networks of accurate levellings of Europe, the existence of systematic errors—the cause as yet unknown—the probable value of which, although much greater than those of accidental errors, only considered up till now, is calculated to be between 0·1 mm. and 0·2 mm. per kilometre for the French, Spanish and Prussian networks. This being so, the researches and efforts of those in charge of great levelling undertakings should certainly aim at reducing the systematic errors.

According to verifications made in Austria by Colonel Sterneck, and confirmed by other observers, the intensity of gravity has a slight diurnal oscillation. The communication of the captain of the ship *Von Kalmar* states that the officers of the Austrian Marine have determined the intensity of gravity in thirty-nine stations, situated in different seas of the world. Prof. Vogler, of Berlin, exhibited an accurate levelling instrument (*niveau de précision*) constructed on the principle of the cathetometer, and metallic levelling rods, formed of two rods of steel coupled with a rod of zinc, and covered with a layer of aluminium. These new arrangements would permit the inventor to reduce the accidental errors of the levelling; but it is doubtful if it would be the same for systematic errors.

The principal and most laborious task of the Congress consisted in drawing up a new diplomatic convention, in place of

that which, since 1886, has governed the existence of the Association, and expires next year. For this reason, important modifications have been introduced into the future functions of the Association.

In view of the construction and maintenance of international stations for geodetic or astronomical observations, its budget will be increased from 20,000 to 75,000 francs.

Under the new organisation, the various German States have been fused into the German Empire with one vote. The old permanent commission, which used to meet once a year, now disappears. Only the general conferences will be continued, and they will take place every three years, as formerly. In these assemblies special commissions will be formed for each branch of study of the Association.

M. Faye has been unanimously re-elected as President of the new Association, with General Ferrero, Italian Ambassador in London, as Vice-President, and Dr. Hirsch, Director of the Observatory in Neuchâtel (Switzerland), as Secretary.

MEETINGS OF AFFILIATED SCIENTIFIC SOCIETIES IN AMERICA.

AN important series of scientific meetings was held at Philadelphia, December 26-28, under the leadership of the American Society of Naturalists, and including six other Societies. The opening address of President Edward D. Cope to the Naturalists' Society was on the formulation of the natural sciences. A discussion on the flora and fauna of the Antarctic and adjacent regions occupied most of the time of this society. Angelo Heilprin opened the discussion. He said that very little was known about the Antarctic region. It appeared to him that the coast-line of this region did not outline a continent, but only a group of islands. The supposed continent had been regarded as destitute of vegetable life till lichens were discovered there last year. It is thought from geological formations that the continent was once connected with Australia, South America, and perhaps Africa. W. B. Scott said that a study of fossils of animals shows that Australian forms are found in South America, but no South American forms in Australia; thus indicating that there was first a connection between Australia and the southern continent, and later between South America and the southern continent.

N. L. Britton gave a list of plants, and Theodore Gill of fresh-water fishes, to show the connection between the southern continent and Australia and South America.

The officers elected for the Naturalists' Society are: President, W. B. Scott; Vice-Presidents, W. G. Foster, C. O. Whitman, and Theodore Gill; Secretary, H. C. Bumpus; Treasurer, J. B. Smith.

There was a large attendance at the meeting of the Geological Society of America. President N. S. Shaler (in the chair) read a paper on the relations of geologic science to education. Among other papers read were one by C. R. Van Hise, on the movements of rocks under deformation, and a description, by Sir Robert Bell, of the land about Hudson Bay.

Officers elected were: President, Joseph Le Conte; Vice-Presidents, Charles H. Hitchcock and Edward Orton; Secretary, H. L. Fairchild; Treasurer, J. C. White; Editor, J. S. Brown.

The American Psychological Society listened to the annual address of the President, J. M. Cattell, and to a large number of papers by members. An interesting discussion on "Consciousness and Evolution," was opened by William James, and participated in by E. D. Cope, J. M. Baldwin, C. Sedgwick, G. T. Ladd, G. S. Fullerton, J. H. Hyslop, D. S. Miller, and Wesley Mills.

The Anatomical Society of America was briefly addressed by the President, Thomas Dwight. An interesting paper was read by Burt G. Wilder, on "The Cerebral Fissures of Two Philosophers." The brains referred to were those of Chauncey Wright, of Cambridge, and James Edward Oliver, of Cornell, both of which the lecturer exhibited.

Officers elected were: President, Frank Baker; Vice-Presidents, B. G. Wilder and F. J. Shepherd; Secretary and Treasurer, D. S. Lamb.

The American Morphological Society had papers by C. S. Minot, Bashford Dean, and others, and elected the following officers: President, E. L. Mack; Vice-President, H. F. Osborne; Executive Committee, E. G. Conklin and W. Patten.

A meeting of the American Physiological Society was held, at which several papers were read.

The meeting of the American Folk-lore Society was, of course, the most popular. Washington Matthews presided, and read a paper on the poetry and music of the Navajoes. He finds that the tribe has many legends, songs, and formulated prayers. They have an elaborate religion, with symbolism and allegory that might vie with the Greeks. Daniel G. Brinton read a paper on "American Cuss Words," and J. H. McCormick on "Folklore of the Southern Negroes." Captain John G. Bourke read "Notes on some Arabic Survivals in the Language and Folklore of the Rio Grande Valley," in which he traced the similarity of names which the Mexican uses for his common articles of food with those used by the Moslem; and also showed similarity of customs of the two nations.

Officers elected were: President, John G. Bourke; Vice-Presidents, Stewart Culin, Franz Boaz; Councillors, J. W. Ellsworth; Hall Chatelain, J. H. McCormick.

A general lecture was given on Thursday evening by Prof. Wm. B. Scott, on the "Lacustrine Formations of North America and their Mammalian Fossils." The vast plains east of the Rocky Mountains were, in the Pliocene age, fresh-water lakes. Large numbers of fossils, particularly mammals, have been taken from them. Prof. Scott argued the identity of the American fauna of that age with that of France and the valley of Lausanne in Switzerland at the same period.

The affiliated societies were entertained during the days of session by the University of Pennsylvania, and a banquet was given on Friday evening at the Hotel Lafayette. Prof. Cope presided, and the address of welcome was made by Dean Fullerton, of the University.

GEOLOGY IN GLASGOW UNIVERSITY.[1]

YOU are doubtless aware that last year I entertained and expressed the rash expectation that I should not again meet a class as lecturer on geology. "I thought to pass away before, and yet I still am here." An explanation is therefore necessary; I must, in fact, detail the history of the subject in this University, so as to purge myself of censure in respect that the University is, in this particular, behind the time, and far behind what Glasgow, above all, has a right to expect that its University should be.

When I came to Glasgow the old custom prevailed of interlarding the lectures on zoology with those on geology. In my time in Edinburgh, Edward Forbes gave four lectures on zoology, setting aside Friday for geology. In 1867 I separated the two subjects, lecturing twice daily during that summer, and raising a brief revolt amongst the medical students, who thought themselves defrauded of their rights. Brief, for the clamour died quickly when they found themselves at liberty to attend the second lecture without paying a fee; their abnormal thirst for knowledge at once contented itself with what was required for the professional examinations. This was the first complete course given in Scotland, and anticipated by four years the foundation of the Murchison chair in Edinburgh. In 1872, on the establishment of a degree in science, geology was made compulsory for that, as it had previously been for the certificate of proficiency in engineering science. Thereon I began to urge the claims of a subject which had been thus quietly introduced to a prominence not previously granted to it in this city. The Mining School started in Anderson's College some years before had collapsed, those who owed wealth to their mineral property taking no interest in the effort which not even the excellence of Mr. Prior as a teacher could sustain. The hearty support given me in my crusade by Dr. (now Sir Charles) Cameron deserves to be recorded, for he was the only one who appreciated the importance of the movement, the only one who stirred a finger to help me. Wealthy coal- and iron-masters saved their money, some by the Mrs. McLarty plea that they did well enough without trained men, others by modestly saying that they could not properly intrude where their wealthier neighbours saw no need for action. I need not comment on the want of public spirit, of patriotism displayed, which astonished me more perhaps than it would now; but it seemed, and seems strange that a country which boasted Hutton, Playfair, Hall, Macculloch C. Maclaren, Hugh Miller, Lyell, Murchison, A. C. Ramsay

[1] From Introductory Lecture to Course of Geology in Glasgow University by Prof. John Young.

should be without a chair in the subject which they had raised from dependence on mineralogy to the rank of an independent science. Still more did it astonish me, and the astonishment is unabated, that no one among those who owed money to the discoveries of geology was prepared to spend a penny in the way of gratitude. It was not among the wealthy that Pringle Nichol's genius had kindled the zeal for knowledge.

I carried my plaint to the Science Commission, the first Universities Commission, and finally to the second Commission, created in 1889 to "improve the teaching" in the Universities of Scotland. To all the same tale was told, with increasing earnestness as time went on, and the evils correspondingly increased. It was worse than absurd to expect one man to teach two subjects, either of which was more than any one could follow, even with ample time at his command, so rapid were the advances and so unexpected the specialisations enforced by the discovery of new methods and new fields of inquiry. The medical students were always the more numerous class, and the increasing stringency of the regulations for examinations left me no choice but to devote myself to those whom I had to teach summer and winter. Since 1867 the progress of Geology has been marvellous, Mineralogy has entered on a new phase, Microscopy has assumed an indisputable position as arbiter in problems that never could have been discussed, never perhaps have been raised without its aid. I had no time for the field work, which I had carried on as long as possible. Before the G. A. Clark scholarship was founded I had employed lecturers at my own cost to supplement my class work in Mining and Chemical Geology. Thereafter these graduates did as much as possible when they happened to take special interest in my subject. After many years of disappointment and drudgery, such as, I hope, my successors will be spared, drudgery which has deprived me of the chance, save at rare intervals, of original work, with joy I hailed the new, the present Commission with its instruction to "improve the teaching," for now surely was a Commission about to secure for this University, for Scotland, for science, what Murchison in loyalty to his native country and to his beloved studies had rendered possible for Edinburgh. The Commission is now approaching the end of its sittings, and I am still the "double-barrelled gun" that Murchison called me when I took leave of him on resigning the Survey appointment I had held.

In 1874 Mrs. Honyman Gillespie endowed my chair with £200 a year in respect of Geology, and named me a trustee on her gift, a position I accepted, as it was through an indirect and, let me add, an unwitting suggestion of mine that the benefaction was decided on. My intervention, later on, in the case of the W. Baxter scholarship was direct. It was made a proviso that the Professor of Natural History should not vacate the geological lectureship in the event of a chair of Geology being founded unless an equal stipend were continued to him during his incumbency. It shows how carefully Mrs. Gillespie and her advisers had considered the circumstances, that they thus removed from the incumbent any inducement to delay for personal reasons the separation of the two subjects, which the endowment was implicitly intended to bring about. After the evidence I submitted to the Commission, I was amazed to learn that they contemplated the creation of a new chair, not of Geology, but in a subject new to the Scottish Universities, not compulsory for a degree but optional; nay, it is one of six subjects which the candidate for M.A. may select from, viz. English, French, German, Italian, Spanish, History; a collocation which tempts to the suspicion that the subject of imperative necessity was, after all, an after-thought. Such an addition meant diminution of the fee fund, but this concerned my colleagues interested in the financial consequences. My concern was that a subject which an unreformed university had deemed of sufficient importance to have included twenty years before in the requirements for a degree should be passed over, while the new chair of Pathology was the recognition of an exactly parallel want. No; not exactly, for the pathologist had always had ample opportunities for study and research, undisturbed by the need of teaching even a cognate subject, far less one widely apart from his proper work. Parallel, however, in so far as its relation to a degree, the time this relation had existed and the compulsion of attendance were concerned. In contrast with the position of History, let me tell you the relations of Geology: it is compulsory for the degree of B.Sc. in Agriculture, and the certificate in Engineering Science; it is optional for B.Sc. in Pure Science and Engineering; optional also for M.A. Need I say that it is not to the addition of History I object, but to the circumstances attending the addition. The new subject was made to hang loosely to the University, yet it was at once raised to the rank of a professorship, and the means of endowing Geology finally diverted. It seemed a first duty to provide for the better teaching of a degree subject, and under this impression I addressed a very strong remonstrance to the Commissioners. When the evidence and correspondence are published, the reading will be curious and interesting. The interest would have been discounted if the meetings of the Commission had been public, but there would have been less disappointment if precedent had been departed from. After my protest had been disregarded another source of help was revealed, the Bellahouston Trust. The trustees have acted with great generosity, and would have doubled their benefaction by speed had the matter been solely in their hands. It would be wrong to comment on negotiations still pending after two years, but I may say that the salary demanded by the Commissioners as the condition of their consent to the separation of the subjects is not fully realised; the University has no longer in its power the money, which with the Honyman-Gillespie fund and the Bellahouston gift would have met the requirements of the Commissioners. No doubt a lectureship might be established, and perhaps the legal difficulties might be got over; but this is not what the subject is entitled to, either on its own merits or in respect of the position it has so long held in the University curriculum. Here the matter rests.

I hope to have made it clear to those who have blamed me for remissness that I have done all that I can; that the only wrong thing which has brought me into this impass was my voluntary separation of the two subjects. I was younger and more sanguine then. My colleagues in St. Andrews and Aberdeen are still safe in this respect, and I would advise them to keep as they are; the new chairs will come more rapidly.

I regret that no acknowledgments are due to others besides Sir C. Cameron. The General Council of the University has never mentioned the case of Geology: it would not have helped them to any increase of power. The University Court—I mean that created by the Act—has done what it could to forward the chair; it erred, as I think, only in assenting to the creation of another chair without giving due consideration to the elder degree subject, rather to the degree subject, for the other is only an option. The position of the Commissioners is less easily understood, and in the absence of evidence it is but right to conclude that they had sufficient reason for the course they have taken; what it is will appear in their report. My chief complaint goes back of these; it is directed against the mineral proprietors, who have left till now unfulfilled the duty they owe to science and their city. Had the moderate sum I asked twenty years ago been then contributed, there would have been by this time a well-endowed chair, and Glasgow would have been on a footing of equality with Edinburgh as a school of science. It is painful, by way of contrast, to read of the munificence with which citizens have endowed the Mining School of Chicago, to cite one of the many American colleges where public and private spirit have vied in securing the best training that money and skill can give for their engineers, where the presidents of colleges ask and receive abundantly.

But do not imagine that you will not be taught geology. It is true that you will not learn all that I wish you had opportunity of learning. Not one, but three chairs would really content me; but, on the other hand, you will have your attention directed to aspects of the science which another might pass by. It is the practical side of the teaching on which the deficiency lies. If I cannot make you go through the methods of microscopic investigation as we do in the zoological laboratory, you will hear the conclusions to which microscopists are leading us. You will learn the bearing of biological speculation on geology, the value of fossil evidence from the zoological side, and the direction in which we shall probably have to travel in that most important quest, that geological grail, the estimate of geological time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. P. E. Bateman, Fellow of Jesus College, has been appointed an Assistant Demonstrator in Experimental Physics at the Cavendish Laboratory.

The Conference on Secondary Education, previously arranged

for the Long Vacation, will be held in Cambridge during April next, probably towards the end of the month. A large concourse is expected.

Science states that the late Franklin Baldwin, of North Grafton, Mass., has made the following bequests, to take effect on the death of his wife:—Wellesley College, 50,000 dollars to found a chair in Mathematics in memory of his daughter, Katie Emma Baldwin; Smith College, Northampton, 12,000 dollars for scholarships; the University of Vermont, 10,000 dollars for scholarships; Dartmouth College, 6000 dollars for scholarships. The residue of the estate (some 20,000 dollars) is left to Clark University. It is also stated that Mrs. E. G. Kelly, of Chicago, will erect a chapel, at a cost of 100,000 dollars, for the University of Chicago, as a memorial to her brother.

THE following are among recent appointments abroad:—Dr. C. A. Strong to be Lecturer on Psychology in Columbia College; Prof. L. S. Luther to be President of Kenyon College, Gambier, Ohio; Prof. Theodore von der Goltz to be Professor of Agriculture in the University at Bonn; Dr. Dock to be Professor of Pathology and Bacteriology at Jefferson Medical College, Philadelphia; Prof. W. I. Blake to be Professor of Geology and Mining in the University of Arizona; Dr. Hüfner to be Professor of Physiological Chemistry at Strassburg; Dr. H. Rubens, Privat-docent in Physics in the Physiological Institute at Berlin, to be Extraordinary Professor; Dr. L. Neumann, Extraordinary Professor of Geography at Freiburg, to be Ordinary Professor; Dr. Max Le Blanc to be Extraordinary Professor of Physical Chemistry at Leipzig; H. F. Wiebe and Dr. K. Feussner, of the Charlottenburg Reichsanstalt, to be Professors; Dr. A. Weiss to be Assistant in the Mineralogical Institute of Greifswald University. Among recent nominations are: Dr. Otto Mügge to the chair of Mineralogy at Königsberg; Dr. Klemenčic to be Professor of Physics at Innsbruck.

ONE of the best products of the Technical Education movement is the *Journal* of the Essex Technical Laboratories—a monthly bulletin issued by the Technical Instruction Committee of the Essex County Council. The current number contains short descriptions of tuberculosis in cattle, the influence of various manures on pasture, the pruning of trees, the growth of plants, and other subjects, most of them instructively illustrated. A note at the end of the *Journal* announces that "The resources of the County Technical Laboratories are always at the disposal of correspondents as far as such services do not interfere with the regular work of the classes. Such work as testing germinating power and purity of seeds, identification of grasses, weeds, &c., examination of diseased plants and injurious insects, bacteriological examination of milk, &c., may be cited as the kind of help hitherto rendered to inquirers." By affording such opportunities for the acquisition of knowledge, and by the encouragement to observation and exact work offered in the *Journal*, the Essex Technical Instruction Committee is doing work which will benefit the county and the nation.

A MOVEMENT was started last year to secure greater facilities at the University of Paris for such prolonged study with the acquisition of learned degrees as hitherto has attracted English and American students chiefly to Germany. The *Times* correspondent at Paris now calls attention to the promulgation, a few days ago, of a decree reforming the Licence ès Sciences. Partially owing to the greater liberty permitted in the choice of studies, the possibility of moving from one University to another, and the privilege of being examined when they wish, English and American students have hitherto patronised almost exclusively the German Universities. The new decree will permit France to offer, at least as far as the scientific faculties are concerned, attractions equal or superior to those of Germany. As compared with the old regulations, the important provisions of the new decree are as follows:—First, the principle of election is introduced into the groups of studies chosen by the student; secondly, the student may migrate from one institution to another; and, thirdly, he may pass his examinations as he chooses, either singly or *en bloc*. After taking the Licence, the student may secure the doctor's degree upon presenting a satisfactory dissertation. Under the German system the candidate submits his thesis first and passes his examination afterwards, the doctorate being the only recognition he receives. In France, on the contrary, the student by passing his examination first will secure a certificate for every subject which he takes up, and will receive the Licence when he has completed the whole group, regardless of whether he ever takes the doctorate or not.

THE annual general meeting of the Association of Technical Institutions was held on Friday last. The Right Hon. A. J. Mundella, M.P., was elected president for the year, in succession to Mr. W. Mather. In his presidential address, Mr. Mundella referred to the systems of technical education abroad, and said that England was suffering from her past neglect and from over-confidence. As a consequence of the industrial training which the people of Switzerland had received, that country had exported a greater proportion of manufactured articles per head of her population than any other nation in the world. This he attributed wholly to education, the country being without coal and iron. German manufacturers also had the great advantage of employing a body of highly-disciplined men, who thoroughly understood the technique of their occupation. He held that if this country wished to make further progress in technical education there must be co-operation by employers. Elementary education should also be improved, and children should remain a longer time at school. The Association of Technical Institutions existed for the purpose of developing industrial education, but he warned them against becoming mere grant-earners. In a discussion that followed, upon the new syllabus for practical chemistry, regret was expressed that the Department of Science and Art still requires students in the elementary stages to have had practice in qualitative analysis. The alternative scheme for the award of grants based upon attendances as well as examination was discussed, and several alterations in the conditions of the scheme were suggested. Other subjects which were considered by the Association were the standard of success in the Department's examinations last May, and the Report of the Royal Commission.

SCIENTIFIC SERIALS.

American Meteorological Journal, January.—The audibility of fog-signals, by Prof. H. A. Hazen. The recent grounding of a passenger steamer on Great Gull Island in a dense fog, within five thousand feet due west of a second-class siren which was sounding at the time, calls attention to several points referred to in a paper by the same author in the journal for October last. This siren has been heard to a distance of twenty miles under favourable circumstances; but the captain of another steamer, which approached the island from the west at the time of the accident, states that his look-out was unable to hear any sound as they approached the island, whereas, after passing, the whistle could be plainly heard.—Atmospheric phenomena in the Arctic regions in their relation to dust, by Prof. W. H. Brewer. The author states that none of the fogs in high latitudes are so white and opaque as those seen south of lat. 50°, and that it is rare that they are so opaque that large dark objects cannot be seen at a distance of two hundred feet. In the Greenland seas the fogs were, as a rule, very much wetter. Often when the fog was so transparent that objects could be seen for half a mile or even a mile from the ship, the water would drip like rain from the rigging. On returning to the south, where the fogs were very dense and objects could not be seen at a ship's length, there was a marked contrast in their wetness; the air did not appear as if entirely saturated. The dust particles in the air over the southern waters were ample to collect all the moisture, while in the Greenland fogs condensation went on as if there was not nearly dust enough in the air to supply the demand.

Bulletin de l'Académie Royale de Belgique, Nos. 9–10.—At the request of M. Spée, astronomer at the Royal Belgian Observatory, a sealed packet was opened which had been deposited by him on January 8, 1887, and contained the description of an apparatus to enable astronomers to obtain the spectroscopic conditions of a total solar eclipse for the observation and photography of the corona and prominences. It is best described as a body generated by the revolution of a longitudinal section of a direct-vision spectroscope about its longer side, thus producing a series of cones and cylinders. This body is used for the spectroscopic analysis of a cylindrical beam of light proceeding from the chromosphere, and obtained by means of a circular slit of diameter equal to that of the sun's image suitably inserted in the telescope. The less highly refractive glass may also be replaced by a liquid, thus leading to considerable simplification, or the whole may be replaced by a circular grating. It should be noted that an apparatus very similar to this was described by Mr. C. Zenger in 1893.—Does a net impede the

passage of winged insects? by Felix Plateau. The difficulty experienced by insects in passing through a net with meshes three or four times their own size has been variously explained. Some attribute it to the resemblance to a spider's web, others to the apparent multiplicity of obstacles. Experiments made with nets of various shapes and materials show conclusively that the peculiarity of insects in this respect is due to the construction of their eyes, which are more adapted to the perception of motions or changes in surrounding objects than to the perception of form. When flying, insects are incapable of distinguishing a net from a continuous translucid surface, and it is therefore only very rarely that an insect will fly straight through it. It must strike the meshes or alight on them, and will then pass through as it would through any hole of the same size.

SOCIETIES AND ACADEMIES.

LONDON.

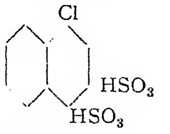
Royal Society, January 16.—"The Rotation of an Elastic Spheroid." By S. S. Hough, Isaac Newton Student in the University of Cambridge.

Recent researches on latitude-variation have brought to light the phenomenon of a periodic motion of the earth's axis of rotation in a period of 427 days. This period being in excess of the theoretical period of 305 days hitherto accepted, Prof. Newcomb has proposed to account for the extension by the failure of the old theory to take into consideration the flexibility of the solid parts of the earth. The author gives an analytical investigation of the motion of a solid body when slightly disturbed from a motion of simple rotation about a principal axis, taking into account elastic distortions due to variations in centrifugal force; the results are found to agree in the main with those obtained by Prof. Newcomb from geometrical considerations. The analysis deals with the case of a homogeneous spheroid of revolution, the ellipticity being such that the body is free from strain when rotating uniformly. Such a spheroid, if of the same size and mean density as the earth and rotating with the same angular velocity, would oscillate in a period of 232 days if perfectly rigid; it is shown that this period would be extended to 335 days in virtue of elastic distortions if the rigidity were equivalent to that of steel. In the case of the earth the period would be still further prolonged in consequence of variations in density, and the period which corresponds to the above degree of rigidity is estimated at about 440 days; whence it is concluded that the observed period may be accounted for by supposing that the earth is capable of elastic deformation, and that its effective rigidity is slightly in excess of that of steel.

Physical Society, January 24.—Captain Abney, President, in the chair.—Mr. Campbell Swinton exhibited some photographs which he had taken by Prof. Röntgen's method. These included several of metal objects inside wooden and cardboard boxes, and a very clear and sharp photograph of the bones of the hand.—Mr. E. Scott showed some geometrical instruments invented by himself and Signor Monticolo. The instrument designed by Signor Monticolo is intended for drawing arcs of circles of such large radius that compasses cannot be employed. It can be used to trace arcs of circles of which the radii vary from 50 cm. to infinity. The second instrument exhibited was a modified form of hatchet planimeter, which Mr. Scott has devised with a view of avoiding some of the defects of the ordinary form of instrument; thus, to avoid the cutting of the paper, which occurs when the knife-edge is sharp, and the side-slip, which occurs when the knife-edge is blunt, the author uses a wheel with a sharp edge. To avoid the inclination of the instrument to one side, which may easily occur with the ordinary form, a flat celluloid plate with a dot at the centre is used as the "tracing point," this plate being kept pressed flat on the surface of the paper. A small wheel with a recording disc is attached, and may be used to measure the distance between the first and last position of the knife-edge. Mr. Scott also described a form of planimeter which he had invented, and in which the l . c and cylinder movement is used to perform the integra on.—Mr. C. V. Boys said that an instrument designed by Mr. Clarkson had been exhibited before the Royal Society, which was capable of drawing arcs of circles of large radius. This instrument only drew an approximation to a circle, but the approximation was so close that it nowhere was more than the thickness of a thin ink line away from the truth. It would be interesting to hear from the author whether Signor Monticolo's instrument drew a rigorously exact circle or not. The upright position of the hatchet planimeter might be secured by using two wheels in place of one. The planimeter described was really a modified form of one he (Mr. Boys) had described before the Society in 1881. Mr. Blakesley gave a short geometrical proof showing that the curve traced by Signor Monticolo's instrument was rigorously an arc of a circle. Mr. Blakesley also drew attention to the fact that the instrument in its present form cannot be used to trace the arc on both sides of the zero line.—Dr. C. V. Burton described an idea for an instrument for drawing circular arcs, which had occurred to him, depending on the use of two wheels of different radii connected by an axle carrying a tracing-point. In the absence of the author, a paper by Prof. J. D. Everett on resultant tones was read by Dr. Burton. The author, after giving a short summary of the Helmholtz theory of the production of resultant tones, goes on to discuss his objections to this theory, and to elaborate a theory of his own. This theory depends on the consideration that, if you analyse into a Fourier series a periodic curve which is compounded of two simple harmonic motions of frequencies n and m, then only two terms are obtained. If, however, some error has been originally made in adding the two simple harmonic motions together, this error being repeated for each wave, then in addition to the two terms of frequency n and m there will be obtained, when the curve is analysed, a term of frequency f, where f is the greatest common measure of n and m. This term of frequency f the author calls the common fundamental of the tones n and m. The "error" in the production of the compound curve the author supposes to be produced during the transmission of the sound by the ossicles of the ear. In support of his theory the author finds that in the violin where the sound-post, like the ossicles of the ear, transmits the vibrations from one portion of the instrument to another, it is easy by sounding two strings in conjunction to obtain combination tones which agree in frequency with those required by this theory. Thus, when the major sixth (3 : 5), the major second (8 : 9), or the minor seventh (5 : 9) are sounded, the fundamental (1) is clearly heard and also felt by the hand holding the instrument. The author has also succeeded in picking out and strengthening this resultant tone by holding a Helmholtz resonator in contact with the body of the violin.—Dr. C. V. Burton, after explaining several portions of Prof. Everett's paper, said that he (Dr. Burton) considered that the author's view in many ways seemed to fit in with the observed facts better than the accepted theory, but still did not appear itself quite free from objection. Prof. Everett supposes that the first term in a Fourier series is always the most important, and although in most cases which occur in practice this may be so, it hardly seems legitimate to take this as a characteristic of a Fourier series.—The thanks of the Society having been given to Prof. Everett and Dr. Burton, the meeting adjourned to February 14.

Chemical Society, December 19, 1895.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read: The liquefaction of air and research at low temperatures, by J. Dewar.—Researches on tertiary benzenoid amines. (1) Derivatives of dimethylaniline, by Miss C. de B. Evans. On heating dimethylaniline with chlorosulphonic acid only the para-sulphonic acid is formed; fuming sulphuric acid must be used in order to obtain the meta-sulphonic acid. The bromination and nitration products of these sulphonic acids are described.—Experiments on the formation of the so-called ammonium amalgam, by J. Proude and W. H. Wood. Solutions of phenols in aqueous ammonia contain ammonium salts because they give ammonium amalgam on addition of sodium amalgam; no mercurial froth is obtained from ammoniacal aqueous solutions of several inorganic salts, so that these contain no ammonium salts. Ammonium salts, when fused or dissolved in anhydrous solvents, cause no swelling of the sodium amalgam; the presence of water seems essential to the formation of ammonium amalgam.—The molecular volumes of organic substances in solution, by W. W. J. Nicol. The atomic volumes of the various elements may be accurately determined from the molecular volumes of organic substances in solution; the constants thus obtained differ somewhat for different solvents.—2 : 1 β-naphthylaminesulphonic acid and the corresponding chloronaphthalenesulphonic acid, by H. E. Armstrong and W. P. Wynne. The 2 : 1 β-naphthylaminesulphonic acid is converted, by the Sandmeyer method, into 2 : 1-β-chloronaphthalenesulphonic acid of which a number of derivatives are described; 2 : 1 : 4′-β-naphthylaminedisulphonic acid is ob-

tained by sulphonating the amido-acid with fuming sulphuric acid.—1 : 3-α-naphthylaminesulphonic acid and the corresponding chloronaphthalenesulphonic acid, by H. E. Armstrong and W. P. Wynne.—Studies on the constitution of tri-derivatives of naphthalene, No. 15. The disulphonic acids obtained by sulphonating 1 : 3-α-naphthylamine- and 1 : 3-α-chloronaphthalene-sulphonic acids, by H. E. Armstrong and W. P. Wynne. On sulphonating these two acids with fuming sulphuric acid, disulphonic acids of corresponding constitutions are obtained; the acid prepared from the amido-acid may be converted by Sandmeyer's method into the acid having the constitution



obtained from the 1 : 3-α-chloro-acid.

Zoological Society, January 14.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair—A communication was read from the Rev. W. J. Holland, containing a preliminary revision and synonymic catalogue of the butterflies of the family Hesperiidæ of Africa and the adjacent islands, with descriptions of some apparently new species. The total number of species of African Hesperiidæ catalogued by Mr. Holland was 349, of which twenty-one were new to science. Fourteen new genera were characterised.—A communication was read from Dr. Arthur G. Butler, which gave an account of a collection of butterflies obtained by Mr. R. Crawshay in Nyasa-land between the months of January and April 1895. Many of the species in this consignment had been obtained at considerable altitudes. It was therefore surprising that comparatively few of them proved to be undescribed, though some of the new forms were of exceptional interest. Nine species altogether were characterised as new.—Mr. P. Chalmers Mitchell read a paper on the intestinal tract of birds.—Mr. F. G. Parsons read a paper on the myology of rodents, in continuation of a former paper read before the Society in 1894.—Mr. F. E. Beddard, F.R.S., gave an account of some earthworms from the Sandwich Islands collected by Mr. R. L. Perkins, and appended descriptions of some new species of *Perichæta*. Of the nine species of earthworms of the Sandwich Islands Mr. Beddard was unable to say that any one was indigenous.—A communication from Mr. Oscar Neumannn gave the description of a new species of antelope obtained during his expedition to East Africa in 1892–95, which he proposed to name *Adenota thomasi*, in honour of Mr. Oldfield Thomas.

Royal Microscopical Society, January 15.—Annual meeting.—A. D. Michael, President, in the chair.—After the annual report and the Treasurer's statement of accounts had been read and adopted, the following were elected as officers and Council for the ensuing year:—President: Albert D. Michael. Vice-Presidents: Rev. Edmund Carr, Frank Crisp, Dr. Richard G. Hebb, Edward Milles Nelson. Treasurer: William Thomas Suffolk. Secretaries: Prof. F. Jeffrey Bell, Rev. W. H. Dallinger, F.R.S. Members of Council: Conrad Beck, Alfred W. Bennett, Dr. Robert Braithwaite, Thomas Comber, Edward Dadswell, George C. Karop, the Hon. Sir Ford North, Thomas H. Powell, Charles F. Rousselet, Prof. Charles Stewart, John Jewell Vezey, Thomas Charters White.—The President, Mr. A. D. Michael, then delivered his annual address. The subject taken was the anatomy of the Acari. It was pointed out that the ordinary text-book definition of an Acarus as a creature in which abdomen and cephalothorax are completely fused is not correct, but that still the great characteristic of the anatomy is concentration; this was illustrated by the author's recent researches relative to the brain and nerves of the Hydrachnidæ (water mites) and other families. The address then dealt with the alimentary organs fully, and several remarkable modifications of the different organs to meet the wants of various creatures were explained.

Paris.

Academy of Sciences, January 20.—M. A. Cornu in the chair.—On two new invariants in the general theory of algebraic surfaces, by M. E. Picard.—On keeping up the motion of a pendulum without interference with its time of oscillation, by M. G. Lippmann. In a pendulum clock certain minute impulses must be given by the movement to the pendulum to overcome the energy losses due to friction, and these interfere to a slight extent with the natural period of vibration. In an ordinary precision clock, attention is directed rather to keeping this disturbance constant than to eliminating it. That a given instantaneous impulse, however, considered by itself, should give rise to no disturbance, it is necessary and sufficient that it should take place exactly at the instant that the pendulum passes through its position of equilibrium. An electrical arrangement is described which fulfils this condition.—On the circulation of the air in the soil, by MM. P. P. Dehérain and Demoussy. A description of an apparatus for the experimental study of the porosity of soils. Air is sucked out from the bottom of a layer of soil of fixed dimensions, and the steady difference of pressures hereby set up is measured, this increasing with the porosity of the soil. The same apparatus serves for the study of the passage of water through soils.—The law of equivalence in the transformations of energy in animals, by M. A. Chauveau. Experimental details of the relation between the work (positive and negative) done by the muscles and the carbon dioxide excreted by the lungs. The conclusion is drawn from these experiments that the mechanical work done by the muscles in lifting a weight requires only an equivalent expenditure of energy. This is stated by the author to be the first experimental demonstration of the law of equivalence for work arising in the activity of animal tissues.—On the specific heats of gases and the properties of the isotherms, by M. E. H. Amagat.—A note on some experiments of M. Witowski on the thermal constants of air between 0 and $-140°$.—Morphology of the limbs of the bony fishes, by M. A. Sabatier.—On the problems of variations relating to double integrals, by M. G. Kœnigs.—On the flexure of beams, by M. M. Duplaix.—Difference in the action of ultra-violet light on static and dynamic critical potentials, by M. R. Swyngedauw. Some experiments in support of a law announced in a previous note.—On a spherical Crookes' tube, showing the reflection of the kathode rays by glass and metal, by M. G. Séguy.—On the reflection and refraction of polarised light, by M. E. M. Lémeray. A geometrical interpretation of some formulæ of Fresnel.—On the solubility of sodium thiosulphate in alcohol, by M. P. Parmentier. Ordinary sodium thiosulphate has been obtained in two modifications, melting at 32° and 47°·9 respectively. Solubility determinations on these, and also on the superfused salt, gave results which are not in agreement with the experiments on the same subject previously published by M. Brunner. The conditions of equilibrium are very complex, and do not appear to follow any simple law.—On the nitrosulphides of iron, by MM. C. Marie and R. Marquis. A new method of preparing Roussin's salt. Sulphide of iron and sodium nitrite are treated at 100° with carbon dioxide. On cooling the pure salt crystallises out, the results of the analyses of which best agree with the composition $Fe_3S_2N_5O_6 + 1·5\ H_2O$. The reactions towards boiling alkali solutions, and water at 200° were examined, but the complete study of the products is reserved for a future paper.—Action of carbonyl chloride upon some hydrogen compounds, by M. A. Besson. The reaction with phosphonium bromide is given by the following equation

$$6PH_4Br + 5COCl_2 = 10HCl + 6HBr + 5CO + 2PH_3 + P_4H_2.$$

Hydriodic acid gives carbon monoxide, hydrogen chloride, and free iodine only, no derivative corresponding to carbonyl iodide being formed. With phosphonium iodide the principal reaction is

$$4PH_4I + 8COCl_2 = 16HCl + 8CO + P_2I_4 + 2P.$$

Hydrogen phosphide, PH_3, is without action upon carbonyl chloride, as is also H_2S in the cold. At 200°, however, the latter gives carbon oxysulphide, COS.—On dichloralglucose and monochloralglucosane, by M. J. Meunier. A study of the condensation products obtained from chloral hydrate and glucose under the action of sulphuric acid.—The weight and composition of the dead covering layer of forests, by M. E. Henry. Figures are given for two classes of deposit, under fully-grown trees, and under brushwood. The weight of the dead layer gradually increases with time for about ten years, and then remains very nearly constant (about 7000 kg. to 8000 kg. per hectare). Complete chemical analyses are given, rendering it possible to construct a chemical balance-sheet for the forest.—The volcanic tufas of Ségalas (Ariège), by M. A. Lacroix. These tufas present a remarkable analogy with the basaltic tufas of Auvergne. A microscopical examination showed that they are undoubtedly volcanic, consisting of labroadorite and andesitic scoria.—On the discovery of a tertiary stratum bearing land

fossils in the neighbourhood of Liverdun (Meurthe-et-Moselle), by M. Bleicher. The fossils include the bones of large mammals and terrestrial shells, including one species of Helix. The shells are rarely intact. As regards the age of this deposit, the evidence points to its being Tertiary, or possibly Pliocene, certainly not Quaternary. This is the first proof of the formation of purely continental land deposits at that time, and in the east of France.

BERLIN.

Physical Society, November 22, 1895.—Prof. von Bezold, President, in the chair.—Prof. Thiesen gave an account of some of his scientific publications; of these, the first deals with a comparison of various mercurial thermometers, of which two were made of Jena glass and one of hard French glass. The others deal with the thermal expansion of solids and liquids. Among these the first treats of the so-called thermic after-effect. and this the author explained by the assumption of minute non-conducting particles distributed throughout the conducting substance. He further developed this hypothesis into mathematical formulæ. The second deals with the linear expansion of rods of glass and zinc, and the third with the relative coefficients of expansion of water, mercury and glass between 0° and 100° C.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—On the Rhythmic Contractility of the Spleen: Prof. Schäfer, F.R.S., and B. Moore.—The Electrical Measurement of Starlight. Observations made at the Observatory of Daramona House, Co. Westmeath, in January 1896. Second Report: Prof. G. M. Minchin, F.R.S.—Contributions to the Chemistry of Chlorophyll. No. VII. Phylloporphyrin and Hæmatoporphyrin: a Comparison: E. Schunck, F.R.S., and Dr. L. Marchlewski.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Telemeters and Range-Finders for Naval and other Purposes: Profs. Barr and Stroud.—Calculation of Horse-power for Marine Propulsion: Lieut.-Colonel Thomas English.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—National Biography: Sidney Lee.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Notes on Steam Superheating: William H. Patchell.

INSTITUTION OF CIVIL ENGINEERS, at 8.—(1) Ironfounding in Green Sand; (2) Malleable Cast-Iron: F. A. Lart.

SUNDAY, FEBRUARY 2.

SUNDAY LECTURE SOCIETY, at 4.—Rubbish: Dr. T. W. Drinkwater.

MONDAY, FEBRUARY 3.

SOCIETY OF ARTS, at 8.—Alternate Current Transformers: Dr. J. A. Fleming, F.R.S.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Manufacture of Linoleum: W. F. Reid.

MEDICAL SOCIETY, at 8.30.

VICTORIA INSTITUTE, at 4.30.—Mount Sinai: Prof. Hull.

TUESDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 3.—The External Covering of Plants and Animals: Prof. C. Stewart.

SOCIETY OF ARTS, at 8.—The Garden in Relation to the House: F. Inigo Thomas.

ZOOLOGICAL SOCIETY, at 8.30.—Second Report on the Reptiles and Batrachians collected by Dr. A. Donaldson Smith on his Expedition to Lake Rudolf: G. A. Boulenger, F.R.S.—On a Collection of Fishes made by Dr. Donaldson Smith during his Expedition to Lake Rudolf: Dr. A. Günther.—Remarks on the System of Coloration and Punctuation in the Beetles of the Genus Calligrapha: Martin Jacoby.—On the Oblique Septa in Passerines and other Birds: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Recent Developments in Gas-Engines: Dugald Clerk.—Monthly ballot for Members.

ROYAL VICTORIA HALL, at 8.30.—Rubies: Prof. J. W. Judd.

WEDNESDAY, FEBRUARY 5.

SOCIETY OF ARTS, at 8.—The Mexican Drainage Canal: F. H. Cheesewright.

GEOLOGICAL SOCIETY, at 8.—On the Morte Slates and Associated Beds in North Devon and West Somerset: Dr. Henry Hicks, F.R.S.—Evidences of Glacial Action in Australia in Permo-Carboniferous Times: Prof. T. Edgeworth David.—On the Structure of the Plesiosaurian Skull: C. W. Andrews.

ENTOMOLOGICAL SOCIETY, at 8.—On the Relation of Mimetic Patterns to the Original Form: Dr. F. A. Dixey.—The Rhynchophorous Coleoptera of Japan. Part IV. Dr. D. Sharp, F.R.S.—The Diptera of St. Vincent: Prof. Williston. Communicated by Dr. D. Sharp, F.R.S.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Determination of Oxygen in Commercial Copper: Bertram Blount.—The Composition of Milk and Milk Products: H. Droop Richmond.—A New Form of Carbonic Acid Apparatus: Cecil H. Cribb.—Laboratory Notes: Alfred H. Allen.

BRITISH ARCHÆOLOGICAL ASSOCIATION, at 8.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On Polystelic Roots of certain Palms: B. J. Cormack.—On a Remarkable Use of Ants in Asia Minor: R. Morton Middleton.

SOCIETY OF ANTIQUARIES, at 8.30.

CHEMICAL SOCIETY, at 8.

FRIDAY, FEBRUARY 7.

GEOLOGISTS' ASSOCIATION, at 7.30.—Presidential Address: Some Structural Characteristics of the Granite of the North-West Himalayas.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, FEBRUARY 8.

ROYAL BOTANIC SOCIETY, at 3.45.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Collected Mathematical Papers of Arthur Cayley, Vol. ix. (Cambridge University Press).—Evolution and Man's Place in Nature: Prof. H. Calderwood, 2nd edition (Macmillan).—Ice-Work Present and Past: Prof. T. G. Bonney (K. Paul).—Traité de Chirurgie: A. Le Dentu and P. Delbet, tome i. (Paris, Baillière).—Graphic Arithmetic: H. D. Ellis, charts 1 and 2 (Philip).—Géométrie Descriptive: A. Gouilly (Paris, Gauthier-Villars).—Remarkable Comets: W. T. Lynn, 4th Edition (Stanford).

PAMPHLETS.—Die Gletscherlawine an der Altels am 11 Sept., 1895 (Zürich).—Misure Assolute degli Elementi del Magnetismo Terrestre: Dr. L. Palazzo (Roma).

SERIALS.—Annuaire de L'Académie Royale des Sciences, &c., de Belgique, 1896 (Bruxelles).—Bulletin Ditto, tome 30, No. 11 (Bruxelles).—Journal of Malacology, Vol. 4 (Dulau).—Revista Sperimentale di Freniatria e di Medicina Legale, Vol. xxi. Fasc. 4 (Reggio Nell' Emilia).—Astrophysical Journal, January (Chicago).—Quarterly Review, January (Murray).—English Illustrated Magazine, February (198 Strand)—Good Words, February (Isbister).—Sunday Magazine, February (Isbister).—Longman's Magazine, February (Longmans).—Chambers's Journal, February (Chambers).—Natural Science, February (Rait).

CONTENTS.

THURSDAY, FEBRUARY 6, 1896.

RECENT PSYCHOLOGICAL LITERATURE.

Outlines of Psychology. By Oswald Külpe. Translated by E. B. Titchener. Pp. xi + 462. (London: Swan Sonnenschein and Co. New York: Macmillan and Co., 1895.)

Studies in the Evolutionary Psychology of Feeling. By Hiram M. Stanley. Pp. viii + 392. (London: Swan Sonnenschein and Co. New York: Macmillan and Co., 1895.)

Mental Physiology. By Theo. B. Hyslop. Pp. xv + 552. (London: J. and A. Churchill, 1895.)

Moral Pathology. By Arthur E. Giles. Pp. viii + 179. (London: Swan Sonnenschein and Co. New York: Charles Scribner's Sons, 1895.)

PROF. TITCHENER has followed up his translation of Wundt's "Vorlesungen über die Menschen- und Thierseele" by performing the same office for Külpe's "Grundriss der Psychologie." This book is one of the most important of recent additions to psychological literature, and it is very fortunate that the task of translation should have fallen into such able hands. The result is an extremely accurate and readable version, supplemented by a new section on the experimental investigation of memory and association, written on the author's suggestion, an index of names, and several minor additions. Prof. Külpe has an acknowledged position as an experimental psychologist, and belongs to the school of Wundt, but his general attitude differs to some extent from that of his master, and more nearly approaches pure presentationism or associationism. The synthetic view of mind as built up of simple elements is rigorously followed, perhaps too rigorously, when the processes which are concerned in reaction time experiments are brought under the heading of connections of elements. The book has two chief divisions; the first deals with the elements of consciousness, which are divided into sensations and feelings, the former being subdivided into those peripherally excited, or, as more commonly called, presentational elements, and those centrally excited, or representational elements. The problems of association and memory are discussed under the latter heading. In the second division two modes of connection of these elements are considered. The first is termed fusion, of which the most striking instances occur in the cases of hearing and of the emotions. The latter are regarded as fusions of sensations and feelings. The second mode of connection was termed by Külpe "Verknüpfung," and this has been translated "colligation." This division is chiefly devoted to spatial and temporal relations. These are regarded as depending on "colligation" of the conscious elements. As regards spatial perception, however, the author inclines towards a nativistic position; and if this were definitely adopted, this subject would come under the elementary conditions of consciousness, and would have to be treated in its more usual place in connection with sensation. This is the least satisfactory part of the book. A comparatively short final division deals with the nature of attention, which is held to be a special state of consciousness in which the elements already described are presented, and is not regarded as a condition or process apart from the conscious content. The author's attitude here seems to be separated by very little from that of the presentationist school. As already stated in NATURE, when noticing the German edition, the book is likely to be largely used as a text-book.

Mr. Hiram Stanley, in his book on the evolutionary psychology of feeling, endeavours to establish the view, of which Horwicz has hitherto been the most prominent advocate, that feeling is the primitive mental state. Mr. Stanley supposes that consciousness first appeared as pain; that the state of the first conscious organism was one of unconsciousness with transient flashes of pain, and that similarly the psychical life of very young infants consists of intermittent pains interrupted by long intervals of sleep. The cognitive side of mind is held to be a later development. Fear is regarded as the primitive emotion which arises with cognition of object and with power of representation. Progress in sensibility is regarded as dependent on effort stimulated by pain; higher mental developments being only attained as the result of severe struggle. The evolution of mind is regarded as dependent on the stimulating influence of pain on volition. Unfortunately these highly interesting conclusions are not reached in a very scientific manner. The contradiction to the principles of evolution involved in the supposition that any of the specialised mental states experienced by us can be primitive, does not appear to have occurred to the author. The conclusions do not appear to be adequately based either on observation or experiment; the view, already mentioned, that the conscious state of the infant is mainly one of pain, appears to be derived from Preyer. The reader is often left in doubt as to whether statements made by the author are facts or opinions; thus, in considering the priority of touch and pain, it is stated that "a man in a 'brown study' inadvertently touching a hot stove has pain, then warmth, then touch sensation"; we are not told whether this order has been actually observed by any one; it is certainly opposed to common experience. Although the author's method is not scientific, and his conclusions questionable, the book has many points of interest. In considering the emotions, there is much skilful psychological analysis; the knowledge of previous thought on the subject is considerable, and there is much that is stimulating and suggestive. The chapter on desire may be mentioned as especially interesting.

Dr. Hyslop's book deals with the relations of the nervous system and the mind, especially in their bearings on mental disease, and a large part of the book is devoted to pathological questions. The book seems to be directed against the materialistic views which prevail among those who have to do with mental disease, at any rate in this country. Current hypotheses about the physiological basis of the higher mental processes are discussed and vigorously criticised, but less attention is paid to the positive knowledge which we possess, especially in relation to sensation and perception. The experimental aspect of psychology is almost wholly neglected, even when it is of a physiological nature, as in much recent

work on the bodily accompaniments of feeling and emotion.

The idea of "moral pathology" is very much in evidence at present, underlying as it does the work of Lombroso and his school. Dr. Giles' book is of a very different kind. It is an unpretentious sketch of moral defects from the point of view of the physician, considered under such headings as causation, diagnosis, prognosis and treatment. The work cannot be regarded as an important contribution to ethical science, but it is written brightly and with common sense. The principles which regulate diagnosis and treatment in medical practice are applied with considerable ingenuity to moral disease. There is an interesting chapter in which the idea of morbid diathesis is applied, and several types of character which predispose to moral disease are sketched.

PROTOTYPES OF THE FUNGI.

Protobasidiomyceten. Untersuchungen aus Brasilien. Von Alfred Möller. Pp. xiv + 179. (Jena: Fischer, 1895.)

THE present work forms the eighth part of Dr. Schimper's "Botanischen Mittheilungen aus den Tropen." The author is well known for his mycological researches, having previously contributed two parts to the above-named communications—"The Fungus-Gardens of some South American Ants," and "Brazilian Fungus-Flowers." To Elias Fries is due the credit of having first reduced the previous chaotic condition of mycology to an intelligent and scientific standpoint; even much beyond what could have been expected, considering that naked eye characters, or at most when aided by a pocket lens, were only available. Berkeley and Tulasne followed, and, aided by the microscope, added greatly to our knowledge of the minute structure and affinities of the various groups of fungi, a knowledge which has been in some instances more readily utilised than acknowledged by their successors. Later, De Bary's classical work indicated clearly what could be done, by means of pure cultures, towards the elucidation of the life-history of species, and a knowledge of true affinities; a method which is being developed at the present day by Brefeld, to the extent that the last-named author has presented us with his idea of the gradual evolution of the fungi, from their algal ancestors to the highly differentiated, asexual condition, represented by the members of the Basidiomycetes. As usual in classifications based on progressive morphological development, connecting links between groups that the evidence at hand suggest as forming a natural sequence, are not always forthcoming. The purport of the work under consideration is to make known a series of such connecting links or primitive types of the great group of fungi known as the Basidiomycetes; and if the author's conclusions prove to be well founded, the neighbourhood of Blumenau, in the province of Santa Catharinea, Brazil, where the material was collected, must be looked upon as a veritable garden of prototypes of the higher fungi.

Brefeld's conception of the Basidiomycetes, characterised by a single feature, the basidium or spore-bearing organ, which must be a terminal, clavate, or sub-cylindrical cell, bearing at its apex four—less frequently two—slender prolongations, or sterigmata, each of which bears a spore at its tip, is accepted, and the evolution of this group from the Ustilagineæ is bridged over by six families, collectively constituting the transition group called Protobasidiomycetes. Four of the transition families agree in having the basidium furnished with transverse septa, hence formed of two or more superposed cells, and bearing the spores laterally. In the remaining two families the basidia are vertically divided into four lobes, each of which runs out into a sterigma bearing a spore at its apex. The sub-families and genera of these families are considered as furnishing transitions to the Basidiomycetes proper. The following illustrate the value of these transition stages, being new sub-families and genera included in the Tremellaceæ, one of the families described above as having vertically divided basidia:—

Protopolyporeæ: Tremellaceæ with the aspect of the hymenium like that of the Polyporeæ.

Protohydneæ: Tremellaceæ with the hymenium resembling that of the Hydneæ.

Genera are as follows:—

Protomerulius: Macroscopic appearance that of the genus Merulius, but with basidia of the Tremellæ.

It is doubtful as to whether the author's view of transition groups, as illustrated above, will be accepted by mycologists. The genus *Merulius* is a typical Basidiomycete, so far as its basidia are concerned, but that something looking superficially like *Merulius*, but having basidia of a lower type, is the prototype of *Merulius*, appears to be more a matter of faith than of conviction. The same argument is applied everywhere; the general appearance is that of some well-known family or genus of the Basidiomycetes, but the structure of the basidia is that of the Protobasidiomycetes.

A wider knowledge of living species, or even a careful study of the material in any large herbarium, will in all probability convince the author that the lower forms of the Basidiomycetes are very plastic, nearly all the simpler genera being superficially mimicked by the unstable species of *Tremella* and its allies. On the other hand, it is not unusual to find specimens belonging to the simpler genera of the true Basidiomycetes presenting a superficial resemblance to species of *Tremella*, &c. As examples may be mentioned *Corticium arachnoideum*, Berk., which is sometimes a typical *Corticium* with a dense, waxy hymenium; at others the substance is very loose, dry, and the basidia scattered, when it mimicks *Hypochnus;* or again, *Coniophora puteana*, Cke., *Forma cerebella*, Sacc., on account of the Merulius-like hymenium. The author has considered structures worthy of sub-family and generic rank, what others would not consider as entitled to rank as a variety of a species.

Nevertheless, if all the author's deductions cannot be accepted, we are at the same time greatly indebted for the large amount of additional knowledge, the result of careful and conscientious investigations, carried out under most favourable conditions, pertaining to those primitive forms of the Basidiomycetes, which hitherto had received but scant attention.

GEO. MASSEE.

OUR BOOK SHELF.

Étude chimique du Glycogène chez les Champignons et les levures. Par Dr. G. Clautriau, Assistant a l'institut botanique, Université de Bruxelles. (Hayez, 1895.)

THE absence of starch from the tissues of the fungi has been generally considered as correlated with their inability to form carbohydrate food material from the CO_2 of the atmosphere, and for a long time it was considered that such carbonaceous reserve materials as they possessed existed only, or at any rate chiefly, in the form of fatty or oily bodies. Within comparatively recent years it has been shown by Errera and other observers that this does not represent the whole of the facts, and that though starch is absent, a very nearly allied body, glycogen, replaces it. The work under notice is a record of some very careful researches, carried out at the Botanical Institute at Brussels, to ascertain the true nature of this glycogen, and whether it is identical or no with the glycogen found in the liver and muscles of many animals.

The chief obstacle in the investigation is due to the peculiar nature of the vegetable organism. Apart from the question of extracting a material like glycogen from a tissue in which cell membranes form a very prominent feature, there remains the difficulty that very many of the decomposition products of cellulose are dissolved by the same solvent, and form mucilaginous material which it is extremely difficult to separate later from the extract of the fungi. The author of the book has with very great pains elaborated a method which enables him to prepare the glycogen in a pure state, and without a very great loss of material. The details of his process are too long to narrate in full; they may be briefly indicated by saying that the fungus is dried at a sufficiently high temperature to destroy the enzyme which is present with the carbohydrate, and reduced to powder by various means. The powder is repeatedly extracted with dilute caustic potash solution till no more glycogen is dissolved. The mucilaginous matter is got rid of by causing an inert inorganic precipitate to be formed in the solution which carries down the mucilage, but leaves the glycogen in solution. The latter is then purified, by treatment which is very fully detailed.

The glycogen has been thus prepared from many species of fungi, including Boletus, Amanita, Phallus and others, also from several yeasts.

Prepared thus, and examined side by side with the animal product obtained from the liver of the rabbit, the two appear to be identical. The solutions are faintly opalescent, and deflect the plane of polarisation to the same extent in the two cases. Both yield maltose when acted on by saliva, and dextrose when boiled for some time with weak mineral acids. Their percentage composition is the same, corresponding, according to the author, to the formula $6(C_6H_{10}O_5)+H_2O$.

The latter portion of the work is devoted to an examination of the chemical and physical properties of glycogen, particularly its relation to iodine, with which it gives a characteristic brown colouration.

Dr. Clautriau is to be congratulated on making a valuable contribution to our knowledge of the carbohydrate metabolism of the group of plants with which he has been engaged.

Popular Telescopic Astronomy. By A. Fowler, A.R.C.S., F.R.A.S. Pp. vi + 77. (London: George Philip and Son, 1896.)

ASTRONOMY has no direct bearing upon industry, therefore it is neglected in this utilitarian age. Technical education is made to include such subjects as political economy, problems of poverty, and great painters; but the authorities which decide what is or is not technical knowledge, draw a line at celestial science. The result is that astronomy is more studied for its own sake than any other science. But by merely reading popular astronomical literature, it is not possible to obtain a truly scientific knowledge of the heavenly bodies; personal observation of the varying aspects of the midnight sky, and of the chief characteristics of celestial objects is essential practical work compared with which book learning is as nothing. Two obstacles have hitherto prevented a wide enjoyment of the beauties of celestial scenery—first, the prohibitive prices which opticians charge for even small telescopes; and secondly, the absence of small and trustworthy guides to the heavens, suitable for those who have no idea what to seek and where to look. There are several most valuable works for the initiated amateur, but few are of a kind that the unexperienced observer finds intelligible. Mr. Fowler's little book removes both the obstacles referred to. In the words of the sub-title, it is a book showing "how to make a 2-inch telescope, and what to see with it," and very admirably is the promise of the title-page fulfilled. The telescope described is made by each student in the course of Astronomical Physics at the Royal College of Science, South Kensington. By following out the instructions given, a serviceable instrument can be constructed, capable of bringing into view a multitude of stars and sights beyond the range of the unaided vision. There can be no doubt that whoever makes his own telescope, not only performs thereby a valuable exercise in optics, but he is not likely to make such foolish mistakes as the astronomical tyro who procures his polished instrument from the opticians, and looks upon it as akin to a box of tricks.

Two chapters of the book are taken up with the details of the construction of the telescope, and hints on the practical use of it. Then come descriptions of star seasons, accompanied by four maps showing the chief constellations; and the remaining seven chapters are devoted to observations of the sun, moon, planets, comets, stars, double stars, star-clusters, and nebulæ. The whole of the work explained can be easily understood and readily performed. The book is practicable as well as practical; every instruction in it can be carried out, every observation described bears the impress of experience. Astronomy will gain more by the publication of this little volume than by the issue of a score of works of a descriptive character.

Anleitung zur Molekulargewichtsbestimmung. Von Dr. Gotthold Fuchs. (Leipzig: Wilhelm Engelmann, 1895.)

THIS little book of 41 pages is specially written as a laboratory guide to the methods of determining molecular weights from observations of the freezing-point and boiling-point of solutions made by means of the Beckmann pieces of apparatus. It contains short historical accounts of the theory of the two methods, and descriptions of the apparatus, including the latest modifications, and the modes of making the observations. Lists of data for calculating results when using different solvents, and numerous examples of the kind of values obtained, taken from Beckmann's papers, are also included. The author is careful to direct attention to the anomalies likely to be met with, and has succeeded in writing a trustworthy account of the present condition of these two widely used methods. J. W. R.

Recettes de l'Électricien. By É. Hospitalier. Pp. vi + 352. (Paris: G. Masson, 1895.)

AN electrician's pocket-book, full of workshop receipts, and containing numerous hints of use in electrical laboratories. In the selection of the receipts, the author has exercised discretion, and in their arrangement he shows that he understands exactly the requirements of electrical artificers and engineers.

LETTERS TO THE EDITOR.

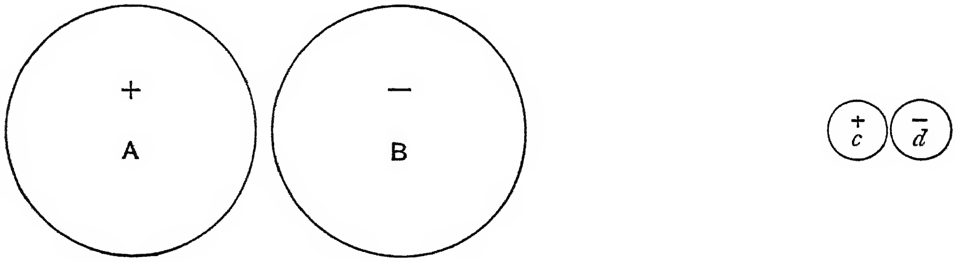
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Velocity of Propagation of Electrostatic Force.

DR. BOTTOMLEY'S note published in NATURE of January 23, quotes an extract from my Baltimore Lectures of October 1884, in which this subject is spoken of, with an illustration consisting of two metal spheres at a great distance asunder, having periodically varying opposite electrifications maintained in them by a wire connecting them through an alternate current dynamo.

For an illustration absolutely freed from connecting wire and all complications, consider four metal spheres, A, B, *c*, *d*, with their centres all in one straight line;—their relative magnitudes and positions being such as shown in the accompanying diagram. Let each of the four be initially electrified, A and *c*, positively, B and *d*, negatively. Let the charges on *c* and *d* be so strong that a spark is only just prevented from passing between them by the influence of B and A. Let A be gradually brought nearer to B till a spark passes between them. Will the consequent spark between *c* and *d* take place at the same instant or a little later? It is not easy to see how this question could be answered experimentally; but remembering the wonderful ingenuity shown by Hertz in finding how to answer questions related to it, we need not perhaps despair to see *it* also answered by experiment.

The elastic solid theory restricted to the supposition of incompressibility (which is expressed by Maxwell's formulas) makes the difference of times between the two sparks infinitely small.



The unrestricted elastic solid theory gives for the difference of times the amount calculated according to the velocity of the condensational-rarefactional wave.

But I feel that it is an abuse of words to speak of the "elastic solid theory of electricity and magnetism" when no one hitherto has shown how to find in an elastic solid anything analogous to the attraction between rubbed sealing-wax and a little fragment of paper; or between a loadstone or steel magnet and a piece of iron; or between two wires conveying electric currents. Elastic solid, however, we must have, or a definite mechanical analogue of it, for the undulatory theory of light and of magnetic waves and of electric waves. And consideration of the definite knowledge we have of the properties of a real elastic solid, which we have learned from observation and experiment, aided by mathematics, is exceedingly valuable in suggesting and guiding ideas towards a general theory which shall include light (Old and New), old and new knowledge of electricity, and the whole of electro-magnetism. KELVIN.

The New Actinic Rays.

MAY I point out that an unnecessary amount of energy is being expended on Röntgen's photographs—I mean electrical energy.

I have succeeded in obtaining perfectly sharp and fully-exposed negatives from an action of four minutes' duration, even when a thin aluminium plate is placed in front of the sensitive film, and the rays are excited in a Crookes' bulb connected direct (*i.e.* with no Leydens inserted) with the secondary terminals of an Apps' induction coil, which gives (in its present condition) a three-inch spark in air when worked, as in the present experiments, by three small accumulator cells. This is much smaller, however, than that used in the published experiments of others who have been doing similar work.

University College, London. ALFRED W. PORTER.

THE accompanying photograph may perhaps interest those who are engaged in the photography of invisible objects. It was taken in the following way. Upon a piece of board I placed a sensitive plate, on this a penny-piece with the obverse side downwards, and on the top of the penny-piece a $\frac{1}{16}$-inch cedar board. The whole was exposed to the light emitted by the burning of sixteen inches of magnesium ribbon at a distance of six inches. I developed with pyro-ammonia. An inspection of the photograph will show a distinct image of the Queen's head.

On repeating the experiment with fifteen inches of magnesium ribbon at six inches, but without the use of the cedar board, the part of the plate surrounding the coin was solarised, whilst the part underneath was over-exposed, so that no trace of the image was visible.

I then repeated the last experiment, using a slow lantern-plate, and burning four inches of ribbon at nine inches distance; on development a faint image of the Queen's head was visible. Hence it is only a matter of exposure and development to produce a much better result than the one presented.

The phenomenon does not appear to be due to the varying thickness of the coin, since the impression of the reverse side has not modified the result, but rather to the different *directions* in which the penetrating rays are refracted from the irregular refracting surface on to the sensitive plate. W. SAUNDERS.

[A FAINT image of the Queen's head is quite visible upon the print received from Mr. Saunders, but it will not bear reproduction.—ED. NATURE.]

A STORY was current at Cambridge some forty years ago that an aspirant to mathematical honours replied to the question, "Construct a prism through which no ray can pass," in the terms following:—

"Take a prism of *wood*: then if no ray passes through, what was required is done. But if a ray does pass through, *paint it*."

Surely a marvellous anticipation of Röntgen's X-rays!

R. B. H.

The Stress in Magnetised Iron.

I AM glad that Dr. Chree, in his letter published in NATURE of January 23, has raised a discussion of this matter, regarding which, as he says, the most contradictory statements are to be found. For some time I have been aware that the passage referred to in my book on "Magnetic Induction in Iron" requires correction. The magnetic stress, $B^2/8\pi$, in a long rod or ring uniformly magnetised, is there spoken of as if it were of the same nature as a simple longitudinal stress of compression, producing a contraction of the length in consequence of the elasticity of the metal. Dr. Chree, if I understand him rightly, would treat it as of the same nature as a simple longitudinal stress of tension, producing an elongation of the iron.

But it now seems clear to me that both of these views are equally wrong. There is no proper comparison, in the general state of magnetised iron, with the stress in a loaded pillar or the stress in a stretched rope.

Take the case of a uniformly magnetised ring, where we have no complications due to end effects. Imagine a plane of section, and call the halves of the ring A and B. According to the first view, A is, as a consequence of the magnetisation of the ring, pushing against B, and B against A. According to the other view, A is pulling B, and B is pulling A. But if A is either pushing or pulling B, the equilibrium of B demands that some other force must act on it to balance this push or pull. No such

force exists. We cannot conceive the action at any section to be simply a stress of push or a stress of pull.

What we know from experiment is that, if the ring be actually cut in two, and a piece of, say, paper be put between the halves, the paper will be squeezed with a stress equal to $B^2/8\pi$. Also, that a pull of that amount would be required to separate the two halves of the ring.

This means that when they are separated by paper the half-ring A is pulling the half-ring B towards it, and the paper is pushing the half-ring B in the opposite direction with the same force, namely $B^2/8\pi$ per square centimetre of the section.

Of course we may, if we please, say that when there is no paper interposed, each half-ring is both pulling and pushing the other. If a mechanical analogy is wanted, it might be found by imagining a stiff tubular ring with a stretched india-rubber band inside it. Suppose, further, that when such a ring is cut through at any section the india-rubber band is not cut, but only its stiff envelope. Then if we try to separate the halves, we have to apply a force equal to the pull in the rubber band. And when the halves are allowed to come together with a piece of paper between them, they will squeeze it with the same force.

Mr. Shelford Bidwell and Dr. More have done what is equivalent to asking whether the change of length which a ring undergoes when it is magnetised can be accounted for by what I have here called the pull of the rubber band acting to shorten the stiff tube in which it is stretched, the tube being treated as having the same section and the same modulus of elasticity as the real iron ring has.

But I see no ground for treating this purely hypothetical strain as a "correction" to be applied, either one way or the other, to the observed changes of length.

The case illustrated by Dr. Chree (on p. 270) is a special one. He there considers the middle piece of a long magnetised bar, separated by actual gaps from the end-pieces from which it has been cut. To preserve the gaps, the end-pieces must be held fixed. He shows that under these conditions the middle-piece is in a state of tensile stress. So it is, but only because of the pull which the other pieces apply to it across the gaps. Make the iron continuous by closing up the gaps, and the tensile stress disappears.

To discuss the sign of the magnetic stress at all in the case of a closed ring, seems much like discussing whether a man sitting in a clothes-basket exerts a pull or a push when he tries to lift it by the handles. J. A. EWING.

Engineering Laboratory, Cambridge, January 28.

DR. CHREE'S letter in NATURE of January 23 corrects an error which it is curious has prevailed so long, and in part forestalls a communication Mr. H. Nagaoka and I had intended to make on the subject of magnetic stress. It might, however, be added that the expression $B^2/8\pi$ used by Dr. More (*Phil. Mag.*, October 1895), and originally given by Mr. S. Bidwell, for the magnetic stress causing changes of length, is incorrect also on another ground, viz. that this quantity is on Maxwell's theory the magnetic stress *in air* (where, according to the ordinary convention as to dimensions, $B = H$) and not in iron, where the expression is necessarily of a different form.

In conjunction with Mr. Nagaoka, I hope before long to discuss this subject more fully.

E. TAYLOR JONES.

University College of North Wales, Bangor, January 25.

The Astronomical Theory of a Glacial Period.

MR. CULVERWELL has pointed out to me that I am in error when I include him among those writers who think that the problem of glacial periods is to be solved by considering only the varying amounts of sun-heat at different epochs. On referring to his paper, which I had not at hand when I wrote, I find that this is the case, and that he is careful to limit his calculations as giving only the variations of temperature due to *direct* sun-heat. He also discusses, though very briefly and inadequately, the effects due to *transference* of heat from one area to another. Although willingly making this correction at his request, I am still, after another perusal of his paper, quite unable to see that it finally disposes of Croll's theory, much less of that modification of it which I have myself set forth.

ALFRED R. WALLACE.

The Fall of the Altels Glacier, September 11, 1895.

JE vous adresse aujourd'hui un travail sur l'Avalanche du Glacier de l'Altels, que vient de publier la Commission des Glaciers de la Société helvétique des Sciences naturelles et qui complète l'intéressant article de Miss Maria M. Ogilvie: "The Gemmi Disaster" (NATURE, vol. lii. p. 573).

Ce travail rédigé par Mr. Heim n'est pas tout à fait définitif en ce que plusieurs points touchant à l'histoire antérieure du glacier de l'Altels n'ont pu être résolus encore. Il serait important de tirer au clair ces points pour pouvoir déterminer avec exactitude les causes de l'avalanche du 11 sept. 1895; mais, pour cela, il nous faut des *photographies* du glacier de l'Altels prises avant l'avalanche et remontant jusqu'à quelques années en arrière si possible. Après avoir fait depuis plusieurs mois des recherches peu fructueuses à cet égard je prends la liberté de m'adresser à vous, Messieurs, pour donner quelque publicité à ces lignes. Persuadé que beaucoup d'amateurs ont photographié l'Altels de l'W., ou du N.W., je les prie de bien vouloir me communiquer leurs épreuves, en indiquant la date (au moins le mois et l'année) à laquelle la photographie a été prise.

En vous remerciant d'avance de votre obligeance, je vous prie, Messieurs, d'agreér l'assurance de ma considération distinguée.

LEON DU PASQUIER.
Secrétaire de la Commission des Glaciers.

Neuchâtel, le 21 janvier.

Remarkable Sounds.

IN Major Head's "Forest Scenes" (London, 1829, p. 205), I have found the passage already quoted by Mr. C. Tomlinson (p. 78, *ante*), subjoined with this phrase: "It being, in real fact and without metaphor, the voice of winds imprisoned on the bosom of the deep." In a similar manner, Olaus Magnus describes the similar sounds thus: "Mais es lacs Septentrionaus gelés, on oit sous la glace une tempête aussi horrible, à raison des vens enfermés sous la glace, qu'on fait d'un tonnerre provenant de la gràde épesseur des nuës." ("Histoire des pays Septentrionaus," Paris, 1561, fol. 21, *b*).

Sebastian Münster, in his article on Iceland, says:—"Car la glace divissee par loppins et brisee en plusieurs parties tourne à l'entour de ceste isle l'espace de huyt moys, et se froisse de si grande impetuosité contre le rivage, qu'elle rend un son horrible et espouantable, et semble advis que ce soit le gemissement ou brayement d'une voix humaine. Cela fait que les plus idiotz croyêt que les âmes des hommes sont la tormentees de froid." ("La Cosmographie universelle," Basle, 1552, p. 1051.) Against this error Arngrimus Ionas writes, but at the same time he admits that "this ice at sometimes by shuffling together maketh monstrous soundings and cracklings, and againe at sometimes with the beating of the water sendeth forth an hoarse kind of murmuring." (Hakluyt, "Principal Navigation," 1599, vol. i. p. 563.)

If it be taken into consideration that so often in the volcanic craters and thermal springs[1] man found the types of the perpetual Abode of Fire, a suggestion would seem quite reasonable that the so-called "Cold Hells" of the Buddhists[2] and the Tauists[3] had been the outcome more or less of such dreary, icy sounds.[4] KUMAGUSU MINAKATA.

January 31.

The Antiquity of the Finger-Print Method.

IN my letter on this subject that appeared in NATURE (vol. li. p. 199, December 27, 1894), I have suggested that the ancient Japanese usage on divorce-papers of the finger-marks was probably adopted from the Chinese "Laws of Yung-Hwui"

1 *Cf.* Hardy, "Manual of Buddhism," second edition, p. 27. I remember a note in NATURE about the Indian confusion of thermal springs with the hell, but at the present moment cannot refer to the number and page.

2 See Beal, "A Catena of Buddhist Scriptures from the Chinese," 1871, p. 36.

3 See "Twan Ching-Shih, Yu-yang Tsah-tsu," Japanese edition, tom. ii. fol. 3, *b*.

4 Indeed, according to Münster, the Icelanders of old believed that their hells were in both the Hecla and the ice.

(*circa* 650-55 A.D.), issued under the reign of the third emperor of the Tang. As these "Laws," however, are nowadays lost,[1] I had but little hope to investigate further the matter. However, elsewhere a passage has lately been found, giving confirmation to my view that the Chinese usage of the finger-prints for identification was current in the time of the same dynasty of Tang.

In the Arabian "Relation des Voyages" (translated by Reinaud, Paris, 1845, pp. 42-43), the merchant Sulaiman, who made several voyages to China and India in the middle of the ninth century A.D. (the time in which the above-mentioned dynasty in China was going to decline), tells us as follows: "Les Chinois respectent la justice dans leurs transactions et dans les actes judiciaires. Si un homme prête une somme d'argent à quelqu'un, il écrit une billet à ce sujet; l'emprunteur, à son tour, écrit un billet, qu'il *marque avec deux de ses doigts réunis, le doigt du milieu et l'index*.[2] On met ensemble les deux billets. On les plie l'un avec l'autre, on écrit quelques caractères sur l'endroit qui les sépare, en suite, on les déplie et on remet au prêteur le billet par lequel l'emprunteur reconnaissait sa ditte. Si, plus tard, l'emprunteur nie sa dette, on lui dit: 'Apport le billet du prêteur.' Si l'emprunteur prétend n'avoir point de billet, qu'il nie avoir écrit un billet accompagés de sa signature et de sa *marque*, et que son billet ait péri, on dit à l'emprunteur qui nie la ditte: 'Déclare par écrit que cette ditte ne te concerne pas; mais, si, de son côté, le creancier vient à prouver ce que tu nies, tu recevras vingt coups de bâton sur le dos, et payeras une amende de vingt mille (fakkoudj) de pièces de cuivres.'"

February 3. KUMAGUSU MINAKATA.

Earthquake of January 22.

ON the morning of January 22 a shock of earthquake was felt throughout Northern Switzerland, and at many places in Southern Germany from Ulm to Strassburg. At Basel the shock was strong enough to awaken many persons, and a crackling noise was heard by almost all observers. The direction of the shock appears to have been from north-east to south-west. The seismometer at the Bernoullianum Observatory indicated 46 min. 16 sec. after midnight (mean European time). According to newspaper reports, the shock was more severely felt in the neighbourhood of Freiburg than here.

A very slight shock occurred also on January 1, 6h. 38m. 54s. in the morning. ALBERT RIGGENBACH.

Basel.

MAGNETIC INFLUENCE OF THE PLANETS.[3]

AN attempt to discover a direct magnetic influence emanating from the planets is described in "Magnetismus der Planeten," by Ernst Leyst. For this purpose the author makes use of the observations taken at St. Petersburg and Pawlowsk during the years 1873-1889, and calculates the average magnetic declination for the days at which the planets are at their greatest and least distance from the earth; also for those days at which the planets are at their greatest eastern and western elongation. The numbers so obtained show certain regularities, which are considered sufficiently marked to indicate a true effect of the planetary configurations. According to the tables given, the declination is increased by 0·2 minutes of arc when Venus is nearest, and is diminished by 0'·32 when it is furthest away. Mercury acts in the opposite direction, diminishing the declination by 0'·29 when it is nearest, and increasing it by 0'·20 when it is furthest. The backbone of an inquiry like this ought necessarily to be found in a careful discussion as to how far an accidental combination of figures could account for the apparent effect. The magnetic declination is subject to so many changes which to us seem accidental, that if we take a certain number out of the whole series of daily averages, they must necessarily show deviations. The whole question then turns on the discussion whether the effects found by Mr. Leyst are sufficiently large and regular to be considered as real. This part of the subject is, unfortunately, treated in an insufficient manner, and, for this reason, the author has not in my opinion made out his case.

We may, however, from Mr. Leyst's numbers, draw the conclusion that even if the effect is a real one, it cannot, as the author considers, be due to an ordinary magnetic force depending in its magnitude on the distance of the planets. Within a few days of conjunction that distance does not vary appreciably, and Mr. Leyst should therefore get more trustworthy results by taking account not only of the days of conjunction, but of a group of days immediately surrounding the configurations. The necessary data are supplied by Mr. Leyst, and it appears that taking Mercury, for instance, the diminution of declination is reduced from 0'·29 to 0'·20 when the preceding and following days are taken into account; while when five days altogether are considered, there is a further reduction of the effect to 0'·15, and when a month is taken, in the middle of which the inferior conjunction lies, there is only a deviation of 0'·08 from the average declination. The other planets show the same fact. The average effect of all the planets amounts to 0'·33, which is reduced to 0'·26, 0'·17, and 0'·08 when the three days, five days, and the month nearest to conjunction are taken into calculation. If the effect is a real one, it must be due to some other cause than an ordinary magnetic action, for it practically vanishes two days before or after conjunctions, when there is very little change in the relative positions of sun, planet, and earth. Mr. Leyst himself draws attention to the rapid diminution of the supposed planetary influence within a few days of conjunction, but considers it to be an argument in favour of his view.

The amplitude of the diurnal variation is discussed; and here, of course, also a planetary effect is found, which, curiously enough, is greater for Neptune and Uranus than for Venus and Mercury. The "probable error" of the result is considered, and is calculated to exceed the supposed effect in the case of Mercury, Mars and Saturn, and to amount to about two-thirds of the effect in the case of Venus, Uranus and Neptune. The author draws the conclusion that the planetary influence is "certain" for the three latter planets and Jupiter.

It is hardly necessary to follow the author further in the complicated results he deduces, by separating what he calls the "primary" and "secondary" extremes, the primary and secondary amplitudes, and the irregular and periodic part of the diurnal variation; the primary and secondary quantities being affected in opposite directions by the mischievous Mercury. In fairness to the author, it must be stated that some of the effects of that planet are found to be in the same direction when the whole period of fifty synodic revolutions is divided into two, which are separately considered. Nevertheless, a careful perusal of Mr. Leyst's work leads to the conclusion that he has not proved his case. Among the many improbabilities of magnetic influences which are hanging over us, that of a planetary effect may for the present be set aside.

ARTHUR SCHUSTER.

[1] K. Konakamura in "Nipon Rikishi Hyôrin," Tôkyô, 1893, vol. vi. p. 24.

[2] In a translation by E. Renaudot (Paris, 1718, p. 33), and thence in Pinkerton's "Collection," London, 1811, vol. vii. p. 192, this sentence is rendered thus: "When any person commences a suit against another, he sets down his claim in writing, and the defendant writes down his defence, which he signs, and *holds between his fingers*." Here no mention is made of finger-marks; instead of it a meaningless clause is given. Reinaud says Renaudot committed errors in his version ("Introduction," p. ii.), and the present case is apparently one.

[3] "Über den Magnetismus der Planeten," von Ernst Leyst. ("Repertorium für Meteorologie," vol. xvii. No. 1. St. Petersburg, 1894.)

THE STORY OF HELIUM.[1]

PROLOGUE.

DURING the last decade, as most of you know, our literature has been enriched by a recrudescence of the short story, generally dealing with very modern human affairs of various kinds from many different standpoints.

But these modern stories, and others that might be referred to, are not the only ones now available. During the last sixty years Egypt, Babylonia, and other countries which might be named, now here and now there, have supplied us with other stories—most precious indications which enable us to study, into a far-reaching past, the beginnings of man's history. These stories, as you also know, were not very easily deciphered—they were all of them hidden away in strangest script; but the hieroglyphics and cuneiform characters, which at first seemed to have absolutely no meaning whatever, have bit by bit been unravelled by the genius of linguistic explorers, until at length we may say that the students of Archæology are in possession of more or less complete histories of the most ancient peoples of the world.

All these histories have not yet been completely written; but my point is that they have been begun, and that even for the beginning of them the greatest skill has been required to transmute the strange hieroglyphics which were first employed by ancient peoples into modern equivalents, so that we can understand what they wished to convey. Here we are in presence of man's earliest attempt at any language; but the story which I, your President, have to tell you to-night, has a very different origin to this, for the reason that, although it is a story, and written, it is true, in hieroglyphics, the hieroglyphics are of nature's invention, and not man's.

The story or fairy tale of science, which has placed us in possession of the most precious truths regarding every star which shines in space, is a story written in nature's hieroglyphics in every ray of light which reaches this planet of ours from the tiniest star.

Now, of course in the hour at my disposal to-night it is impossible for me both to tell you a story, and spend much time upon the alphabet in which the story is written, but there are just one or two words about the alphabet that may be useful. One key to these hieroglyphics, this light story, which is hidden in every ray of light, is supplied to us by the rainbow, which teaches us that the white light with which nature bountifully supplies us in sunlight, is composed of rays of different kinds or of different colours. Many of you know that there is an almost perfect analogy between these coloured lights and sounds of different pitches.

The blue of the rainbow may be likened to the higher notes of the key-board of a piano, and the red of the rainbow, on the other hand, may be likened to the longer sound waves, which produce the lower notes; and as we are able in the language of music to define each particular note, such as B flat and G sharp, and so on, so in these celestial hieroglyphics we are enabled to do exactly the same thing with perfect definiteness, by considering the wave-length of the particular colour with which we have to deal, so that having these wave-lengths we may determine the quality of every kind of light which reaches the human eye, whether from a terrestrial light source, the sun or any other celestial body, including the shooting stars which some of us are hoping to see to-night.

Well, the result of the study of this hieroglyphic language has been that we can in that way determine the chemical source of every light of different colour which can be thus examined in any celestial body, provided always we can obtain the same light-note from some terrestrial substance when we experiment upon them at temperatures high enough to set them glowing in our laboratories. We can determine therefore, by such means, whether in different parts of space we have the same chemical substance, or whether in different stars we are dealing with substances perfectly and completely distinct.

Imagine these hieroglyphics, then, more or less translated, on the principle I have indicated to you, by the labours of Kepler, Newton, Fraunhofer, and other later workers; so that in the case of anything shining anywhere, we can eventually find out something about its chemical and its physical constitution.

Another part of the prologue, before I begin my first chapter, brings us to another line of study, that is to say, the telescopic and visual observations of heavenly bodies.

I take you back to the year 1706, when there was a total eclipse of the sun, visible in Switzerland, and there was one Stannyan, who gave an account of what he saw at Berne. After describing the phenomena of the eclipse he wrote, referring to the sun: "His getting out of his eclipse was preceded by a blood-red streak of light." Of course, in the prephotographic days no autobiographical record of that particular eclipse was obtainable, but we possess photographic records of other similar later eclipses, which may be taken as representing what Stannyan saw, for, in all, the blood-red streak referred to by him has been seen.

The phenomena photographed in all eclipses now-a-days indicate to us Stannyan's observation, for in all, certainly the sun, in getting out of his eclipse, is preceded by a blood-red streak of light, which we now know to represent one of the solar envelopes to which I gave the name of chromosphere in 1868.

Here then ends the prologue, and I begin the first chapter of my story.

CHAPTER I.

In the year 1868, the new alphabet to which I have referred was first utilised in endeavouring to unravel the message which was conveyed to us by a most interesting eclipse observed in India. The "blood-red streak" was now subjected to minute analysis, because practically the spectroscope was now first utilised. The diagrams will indicate the kind of record with which we have to deal in studying these celestial hieroglyphics. We are in one part dealing with the long waves of light, the red; we are in the other dealing with the shorter waves of light, the blue. The work done in that eclipse is indicated by the bright lines—the hieroglyphics—which, when translated as they have been, describe for us the chemical nature of the particular stuff in the sun, which made him put on a blood-red appearance "on his getting out of his eclipse." Taking the notes in the light scale which are lettered in the ordinary spectrum of light, chiefly sunlight, in order that they may be easily recognised and remembered, we learn the particular qualities of the light emitted by the blood-red streak.

We have one quality represented by the line D, another at C, and another at F. Hence the observers in 1868 could tell us very much more about the particular chemical substances which were present in that blood-red streak than Stannyan could, because spectroscopy had not been invented in his day. According to the diagram (Fig. 1), one of the lines is in the position of D. One observer said it was "at D, or near D," and almost the whole of my story depends upon that distinction.

Soon after this eclipse was observed in India, a method, long before suggested, of studying the blood-red streak surrounding the sun without waiting for an eclipse was brought into operation.

By this method it was quite easy to make observations, whenever the sun was shining, perfectly free from any of the difficulties attending the hurry and the worry and the excitement of an eclipse, which lasts only a few seconds.

Further, as the method consists of throwing an image

[1] Presidential Address, Vesey Club, Sutton Coldfield, November 12, 1895, by Prof. J. Norman Lockyer, C.B., F.R.S.

of the sun, formed by a telescope, on to the slit of a spectroscope, so that the spectrum of the sun's edge and of the sun's surroundings can be seen at the same time, exact coincidence or want of coincidence between the bright and dark lines can be at once determined. I may

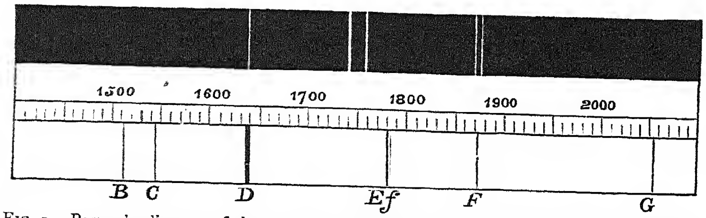


FIG. 1.—Pogson's diagram of the spectra of the sun's surroundings in the Eclipse of 1868. The bright lines seen are shown in the upper part of the diagram; the chief lines in the solar spectrum, red to the left, blue to the right, are shown in the lower part.

remind you that during an eclipse this is not possible, as the ordinary spectrum of the sun, with its tell-tale dark lines, is invisible because the sun, as we ordinarily see it, is hidden by the moon.

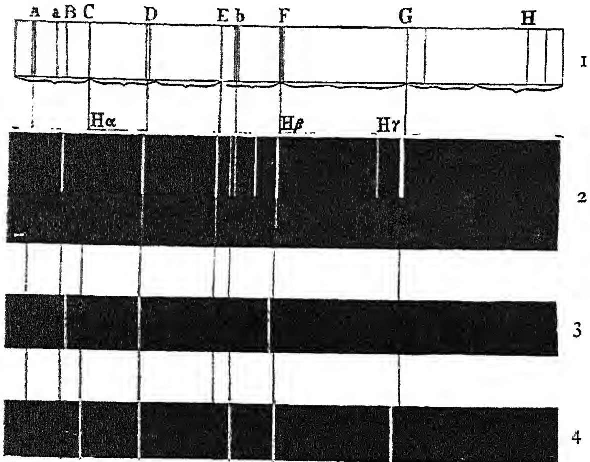


FIG. 2.—Summation of the observations of the spectrum of the sun's surroundings in the Eclipse of 1868. (1) Solar spectrum showing the position of the chief lines (2) Rayet's observations of bright lines. (3) Herschel's observations of bright lines. (4) Tennant's observations.

Working, then, under such very favourable conditions, it was seen that there was certainly a red line given by this lower part of the solar atmosphere coincident with the very important line in the solar spectrum which we call C.

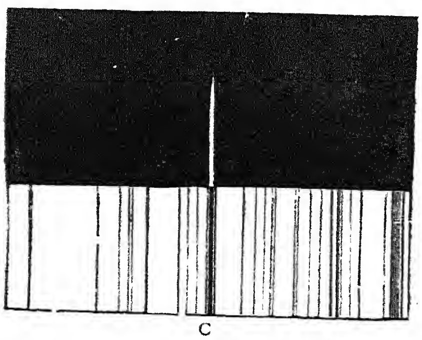


FIG. 3.—The exact coincidence of the red line with the dark line C determined by the new method.

Another part of the spectrum in the blue-green was examined, and there again it was seen that the parts outside the sun gave us a bright line exactly in the position of the obvious dark line in the solar spectrum which is called F; so that with regard to those two most important lines, there was no doubt whatever that we were dealing with the substance which produces these dark lines in the solar spectrum.

Fig. 5 is a diagram of the yellow, or rather the orange, part of the solar spectrum, showing two very important lines, which are called the lines D, due to the metal sodium, the investigation of which was just as important in solving these celestial hieroglyphics as the Rosetta stone was important in settling the question of the Egyptian ones.

Pogson, in referring to the eclipse of 1868, said that the yellow line was "at D, or near D." You will see from this diagram that the new method indicated that "near D" was the true definition. The line in this position in the spectrum, unlike the other two lines which I have indicated, has no connection at all with any of the dark lines in the ordinary solar spectrum. We were therefore perfectly justified in attaching considerable importance to this divergence in the behaviour of this line, taking the normal behaviour to be represented by the two strong lines in the red and the blue-green. The new line was called D^3 to distinguish it from the sodium lines D^1 and D^2.

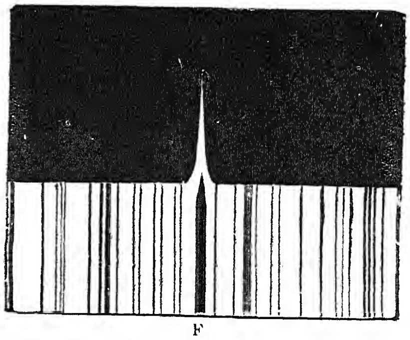


FIG. 4.—The exact coincidence of the blue-green line with the dark line F.

A considerable amount of work was done with regard to the yellow line. It was found that there was no substance in our laboratories which could produce it for us, whereas in the case of the line D we simply had to burn some sodium, or even common salt, in a flame to produce it, and the other lines in the red and the blue-green were easily made manifest by just enclosing hydrogen in

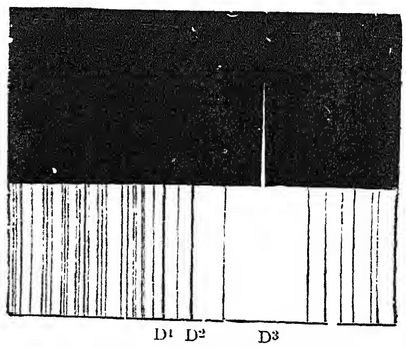
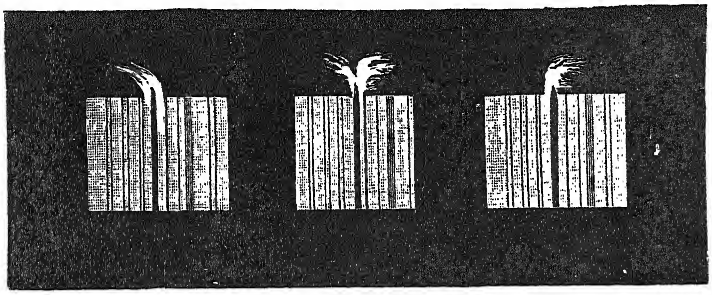


FIG. 5.—The want of coincidence of the range line, D^3, with the dark lines D^1 and D^2.

a vacuum tube, and passing an electric current through it, or observing the spectrum of a spark in a stream of coal-gas.

Now at the first blush it looked very much as if this

line was really due to the same element which produced the others at C and F, and it was imagined that the reason we did not see it in our laboratories was because it was a line which required a very considerable thickness of hydrogen to render it visible. That was the first idea, and Dr. Frankland and myself found that there was very considerable justification for this view, because a simple calculation showed that the thickness of the solar atmosphere, which was producing that yellow line under the conditions which enabled us to see it in our instruments by looking along the edge of the sun, was something like 200,000 miles.



A B C

FIG. 6.—Changes of wave-length of the F hydrogen line when a solar cyclone is observed. A, the change towards the red indicates the retreating side of cyclone. C, the change towards the blue indicates the advancing side. B, the whole cyclone is included in the width of the slit, and both changes of wave-length are visible.

Hence, in order to get a final decision on this point, there was nothing for it but to tackle the question from a perfectly different point of view, and the different point of view was this. The work had not gone on very long before one found minute alterations in the positions of these lines in the spectrum; the blue line, for instance, might sometimes be slightly on one side, and sometimes on the other of its normal position. Further work showed that in these so-called "changes of wave-length" we had a precious means of determining the rate of movement of the gases and vapours in the solar atmosphere.

Fig. 6 indicates how these changes of wave-length are shown in the spectroscope. The lines are contorted in both directions, and sometimes to a very considerable extent, indicating wind-movements on the sun, reaching, and sometimes exceeding, 100 miles *a second!*

Well, then, you see we had here a means of determining whether the yellow line was produced by the same gases which gave the red and blue lines, because if so, when we got any alteration in the position of the red and blue lines, which always worked together, we should get an equivalent alteration in the position of the yellow one.

I found that the yellow line behaved quite differently from either the red or the blue line; so then we knew that we were not dealing with hydrogen; hence we had to do with an element which we could not get in our laboratories, and therefore I took upon myself the responsibility of coining the word helium, in the first instance for laboratory use.

This kind of work went on for a considerable time, and what one found was, that very often in solar disturbances we certainly were dealing with some of the lines of substances with which we are familiar on this earth; but at the same time it was very remarkable that when the records came to be examined, as they ultimately were with infinite care and skill, it was found that not only did we get this line in the yellow indicating an unknown element associated with substances very well known, like magnesium, but that there were many other unknown lines as well. Within a few months of my first observations, several new lines about which nothing was known were thus observed. The place of this orange line I determined on October 20, 1868. Among many other lines behaving like it, two at wave-lengths 4923 and 5017 were discovered in June 1869, and afterwards another at 6677, while Prof. Young noted another in September 1869, at 4471. He wrote:

"I desire to call special attention to 2581·5 [Kirchhoff's scale], the only one of my list, by the way, which is not given on Mr. Lockyer's. This line, which was conspicuous at the Eclipse of 1869, seems to be *always present* in the spectrum of the chromosphere. . . . It has no corresponding dark line in the ordinary solar spectrum, and not improbably may be due to the same substance that produces D^3."

This same line was noted also by Lorenzoni, and named *f*.

Then with regard to solar disturbances. Let me refer in detail to a diagram indicating some results arrived at by the Italian observers. We are dealing with the spectroscopic record of two slight disturbances in a particular part of the sun's atmosphere. The spectroscope told us that in that region there was a quantity of the vapour of magnesium which was collected in that place. Then we find that another substance, about which we again know nothing whatever, is also visible in that region, and then we get the further fact that in those particular disturbances we get four other spectral lines indicated as being disturbed, and of those four lines we only know about one.

In that way it very soon became perfectly clear to those who were working at the sun, that in all these disturbances, or at all events in most of them, we were dealing to a large extent with lines not seen in our laboratories when dealing with terrestrial substances; this work went on till ultimately, thanks to the labours of Prof. Young in America, we had a considerable list of lines coming from known and unknown substances which had been ob-

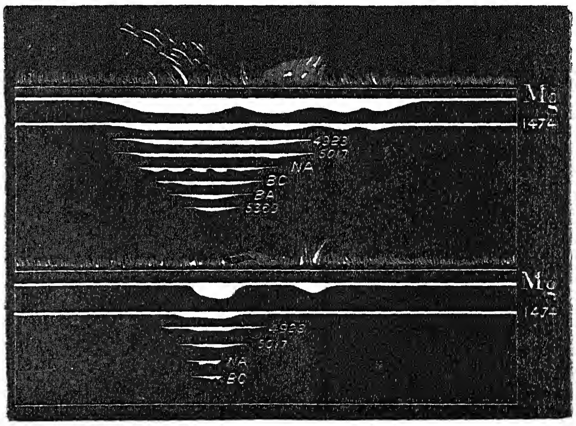


FIG. 7.—Tacchini's observations of two slight solar disturbances showing the height to which the layers of the different gases extend. Magnesium vapour is highest of all, and is furthest extended; next comes a gas of still unknown origin, indicated by a line at 1474 of Kirchhoff's scale, and so on.

served under these conditions in the solar chromosphere and Prof. Young was enabled to indicate the relative number of times these lines were visible. For instance, the lines which are most frequently seen under these conditions he indicated as represented by the number 100, and of course the line which was least frequently

seen would be represented by 1; and therefore from these so-called "frequencies" we got a good idea of the number of times we might expect to see any of these disturbance-lines, when anything was going on in the sun.

It was this kind of work which made Tennyson write those very beautiful lines:

> "Science reaches forth her arms
> To feel from world to world"

And then he added:

> "and charms
> Her secret from the latest moon."

I mention this because Tennyson, whose mind was saturated with astronomy, had already grasped the fact that what had already been done was a small matter compared with what the spectroscope could do; and now the prophecy is already fulfilled, for by means of the spectroscopic examination of the light from the stars we can tell that some of them are double stars, that is to say, in poetic language, stars with attendant moons. Although we can thus charm the secret from each moon by means of the spectroscope, to see the moon it would require a telescope not 80 feet long, but with an object-glass 80 feet in diameter, because the closer two stars are together the greater must be the diameter of the object-glass, independently of its focal-length and magnifying power.

(*To be continued.*)

THE CAMBRIDGE NATURAL HISTORY.[1]

THE second volume of this series (vol. v.), to make its appearance is devoted, with the exception of articles on the Prototracheata (pp. 3–26) and Myriapoda (pp. 28–80), to the Insecta, which will occupy also the whole of vol. vi.

Mr. Sedgwick gives a concise account of *Peripatus*, which, being derived mainly from his own well-known papers, does not call for extended notice; the descriptions of anatomy and development are written in a somewhat technical style, but are not over-elaborated. If it were thought necessary to reprint an easily-accessible list of the known and doubtful species, it should certainly have been revised. No records are noted since 1888; *P. juliformis* is given as a doubtful species, whereas at most it is incompletely characterised, and *P. trinidadensis* actually figures as "n. sp." A map, serving as frontispiece, shows the distribution; but the records from Peru and Chili seem scarcely to justify the inclusion of so much of the arid western littoral of South America.

Myriapoda are not a fascinating subject, but Mr. Sinclair's article, though slight and somewhat wanting in style, gives many particulars of interest about them. The author is clearly a morphologist rather than a systematist, and has made a serious mistake in employing a classification so antiquated as that of Koch, who knew little of extra-European forms, and whose characters, if rightly transcribed, are far from accurate. Mr. Sinclair prefers to disregard the work of systematists who have dealt with separate families only; but a system by Bollman of the whole class (or classes, according to some specialists), published in 1893 in *Bulletin* xlvi. of the United States National Museum, has been overlooked. In the section on development no mention is made of the reversal of the embryo referred to on p. 216 of the work. This was a matter for the editors, as is indeed the whole subject of embryology. The details of early embryonic development are so similar, that there is a risk of useless repetition and of insufficient stress on points of difference unless some co-operation is instituted among contributors. The figures of species are copied from Koch's "Die Myriapoden," and, though the fact is not stated, that of *Cermatia variegata* was drawn from an example which had lost six pairs of legs!

In no branch of zoology has the influence of modern morphological and biological research been of slower growth than in entomology; the subject is so complex, so dominated by taxonomy and an unwieldy literature, that few entomologists have the energy to leave their immediate field of study in order to gain any general knowledge of the natural history of insects. For this the responsibility rests largely with the authors of the many text-books on entomology, who for the most part have been content to follow an antiquated method, basing their work on a substructure of classification, and ignoring families of the highest interest from all points of view except those of the collector and systematist, in order to fill their pages with a tedious procession of names and useless details.

For many years there has appeared no such valuable or original work on insects as this of Dr. Sharp promises to be, when completed. The author has rid himself of the chains of the systematist, and has endeavoured, in

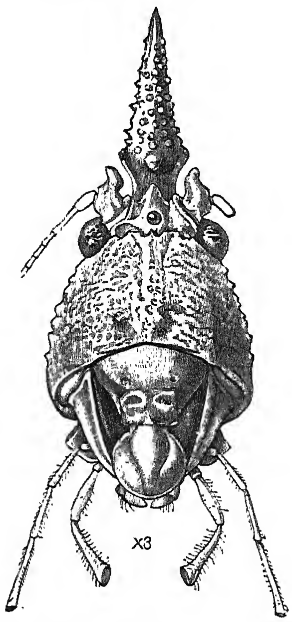


FIG. 1.—Front of head of *Copiophora cornuta*, female. Demerara.

the most thorough and catholic spirit, to give a just view of the many points of interest, whether in structure, development or habits, which attach to this, the richest class of the animal kingdom.

In such a task, one does not look for novelty in facts or theories, though there is ample evidence of independent thought and investigation. It is in the selection and treatment of subjects that Dr. Sharp's originality is shown, and in these the book stands absolutely alone. It is a real and new pleasure to read a work of so broad a scope, in which so much is entirely unknown except to the closest students of recent literature, in which families such as *Thysanura*, *Hemimeridæ*, *Embiidæ*, or *Termitidæ* are adequately treated, and where due regard is paid to the writings of students such as Brauer, Grassi, or Cholodkowsky.

Though familiar insects are by no means neglected, and much that is interesting and new is said even about the earwig and cockroach, the number of strange and rare forms discussed is quite extraordinary. No one knows the literature of the subject better than the author,

[1] "Peripatus, Myriapods, Insects." By A. Sedgwick, F. G. Sinclair, and D. Sharp. Pp. xii + 584. (London: Macmillan and Co., 1895.)

who has ransacked it in a way that it would have been hopeless to attempt without the preparation gained by many years' work in connection with the *Zoological Recor..*

His style is graphic and pleasant and, even when he is most erudite, he is never dry. Nevertheless, the book will appeal with more force to the expert than to the beginner. The definitions are often vague, notably in the chapter on external structure. This arises less from any fault in the author's method than from a reluctance to give definitions which do not embrace all known variations from a common type. To those who can read between the lines this vagueness presents no difficulty, but we suspect that the general reader will fail sometimes to get a clear conception of the subject. The insufficiency of our present knowledge is a favourite and over-emphasised text of the author, who does not conceal his dislike both to generalisation and the acceptance of morphological axioms. Though he rarely expresses his opinion, even on matters where it would be most welcome, in a remarkable footnote (p. 91) he suggests that the wings, equally with the legs, are "appendages." He might be thought to protest against the limitation of the term to a single homologous series, but his remarks on the possibly duplex origin of the thoracic somites tend to negative this view. That there can be any homology between the legs and wings is a dangerous suggestion to hint at in a work not intended solely for critical readers.

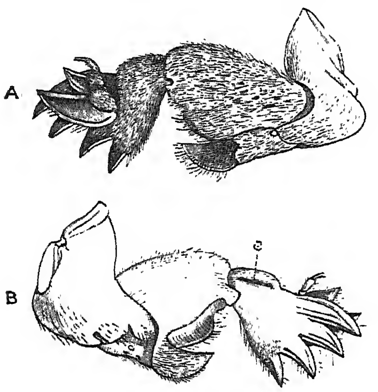


FIG. 2.—Front leg of the mole-cricket. A, outer; B, inner aspect; *c*, ear-slit.

Where so much is novel, it is impossible, within the limits of a notice, to touch on even a small part of the subjects dealt with in the work: the development of the antennæ in *Forficulidæ*, the mimetism of *Mantidæ*, the economy of the Termites, the insects of the coal-measures, the formation of galls, these are examples of many topics discussed in the light of the most modern researches.

The chapters in this volume treat of external and internal structure, development and classification, and, out of the nine orders proposed, of the Aptera, Orthoptera, Neuroptera, and part of the Hymenoptera (Sessiliventres and Parasitica). The remaining orders will occupy vol. vi. of the series.

Of the chapter on development the most suggestive part is that on metamorphosis. Dr. Sharp urges that this phenomenon is yet very imperfectly understood, owing to our ignorance of the underlying physiological changes, and that nothing can be postulated about it without taking into account the processes of embryonic development and of such deviations from the normal course as hypermetamorphosis and the extraordinary changes undergone, for example, by parasitic Hymenoptera. The view that ecdysis is correlated solely with growth, is rejected in favour of Eisig's suggestion that it is a means of excretion.

It follows that metamorphosis is here regarded as of subordinate importance in classification, and though the usual definitions of its extent are rejected, no alternative scheme on a physiological basis is proposed. It is quite unlikely that entomologists will adopt the author's extreme views, but these pages, the result of much thought, will come as a surprise to those who have a comfortable belief in the fixity of the accepted degrees of metamorphosis, degrees which, as Camerano has said, are purely scholastic.

Sexual phenomena, such as heterogamy or dimorphism, are treated only in connection with the forms which exhibit them, but at the end of the chapter on internal anatomy there is a short paragraph on parthenogenesis and pædogenesis. It is nowhere indicated that the latter is an extreme form of the more general phenomenon of neotenia, alluded to under the *Termitidæ*.

Little importance is attached to the threadbare question of the division of the class into orders, and in the arrangement here adopted for convenience and without discussion the undue complexity of some recent systems has been, we think, wisely abandoned. Nine orders are indicated: the Neuroptera include the Pseudoneuroptera and Mallophaga, and two small orders only are kept separate, the Aptera (for Thysanura and Collembola) and the Thysanoptera. The extension of Neuroptera to its original limits is in accordance with the views of some recent writers, for example, Brongniart. But with respect to the Aptera, which is coterminous with Brauer's Apterygogenea, attention has not been paid to Grassi's recent admission that the Thysanura, in common with all existing insects, may be derived from winged forms. They present many primitive features, but these are compatible with their place as the lowest Orthoptera, the homology of the abdominal styles with the legs having been lately seriously questioned. Though the inclusion of the Mallophaga in Neuroptera is not new, it is a pity that no reasons are given for an association which, however sound, is hard to appreciate.

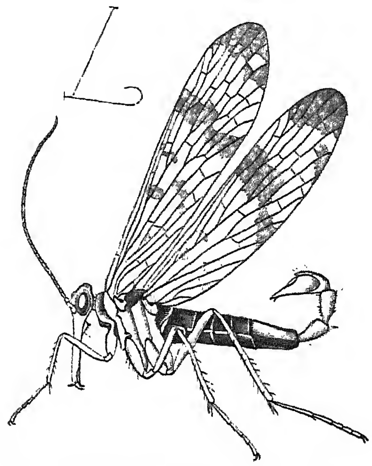


FIG. 3.—*Panorpa communis*, male. Cambridge.

Of the variety of subjects in the chapters on the separate orders, we have already spoken. The Hymenoptera, being more homogeneous, are treated in somewhat less detail than the others. A figure of some of the manifold forms assumed by the petiolate abdomen would have been welcome, and among structural points there is no reference to the strange nipper-like front tarsi of *Gonatopus*.

In the chapter on *Acridiidæ*, no mention is made of the fact, important in connection with the migratory

instinct, that the permanent homes of locusts are situate in sterile land, and it would have been well to remove the common misconception that the winged swarms are the chief enemies of the agriculturist; it is against the march of the larvæ, here graphically described in the words of an eye-witness, that he has specially to guard.

There are a few inaccuracies and examples of loose expression, of which one or two may be mentioned. The author states that "the anterior portion of the intestine is the smaller, and is frequently spoken of as the colon," whereas elsewhere he alludes specifically to the ileum, which is often distinguishable. Certain glands in connection with the uterus are twice called the "serific," once the "sebific" glands; which term is meant is not clear. He adapts the term "instar" from Fischer to denote the form of an insect during a "stadium," that is, between consecutive ecdyses, but elsewhere he speaks not quite consistently of different instars as connoting a change of form, as well as of stadium. The reference to Chatin's views on the morphology of the mandible, would lead one to suppose that Chatin had found articulated mandibles in *Embia*. This is not the case; Chatin merely compared the parts of the mandibulate mass with the joints of the maxilla, and did so for many mandibulate insects and not *Embia* alone.

The standard which this work sets, if followed throughout the series, will leave the "Cambridge Natural History" without a rival. The book is one to be read not merely by entomologists, whose work it will certainly influence, but by general zoologists. The attention paid to insects in zoological teaching is quite disproportionate to the place they occupy in the animal kingdom; but hitherto zoologists have had no guide to what is best worth knowing on the subject.

The volume presents all the beauty and finish which mark its precursor in the series. The illustrations, original or from original papers, are admirable; some of these we are permitted to reproduce. Fig. 120 has been drawn in an inverted position and is not quite clear, and a much better figure of *Cylindrodes* than the one given, accompanies Gray's original account of the genus.

W. F. H. BLANDFORD.

MEDICAL APPLICATIONS OF RÖNTGEN'S DISCOVERY.

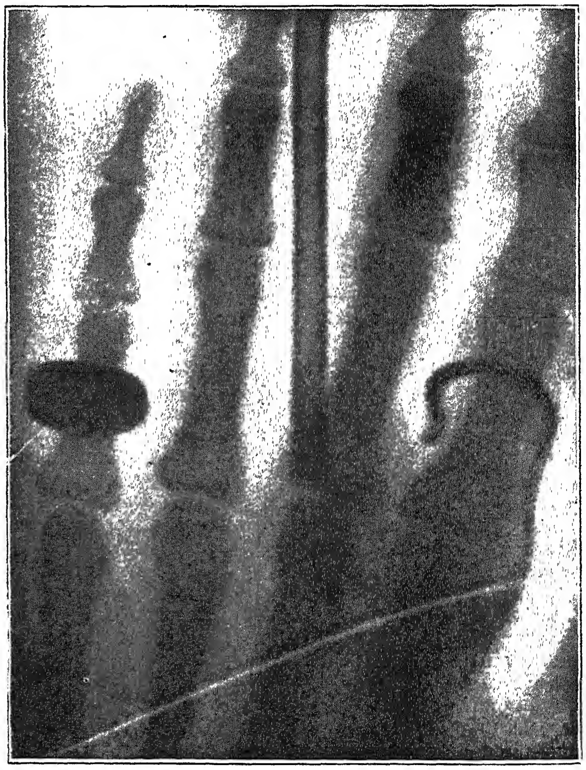
THE new photography has received the official recognition which is usually given to scientific discovery in Germany. Prof. Röntgen has been honoured by the Emperor, and the Prussian Minister of War has caused experiments to be made in order to discover whether the method can be applied successfully to army surgery. A series of photographs of bone injuries have shown so clearly the nature of the wounds and the position of imbedded projectiles that it has been determined to carry on the experiments on a larger scale.

Medical science seems likely to benefit much by the application of Prof. Röntgen's discovery. The *British Medical Journal* thinks, as an aid to diagnosis of obscure fractures and internal lesions generally, the new photography will be of great value. From our contemporary we note that already a beginning has been made in this direction, and Prof. Mosetig, of Vienna, has taken photographs which showed with the greatest clearness and precision the injuries caused by a revolver-shot in the left hand of a man, and the position of the small projectile. In another case the same observer detected the position and nature of a malformation in the left foot of a girl with entire success. Prof. Lannelongue, of Paris, has also been successful in photographing some of his cases in his ward at the Trousseau Hospital, and, assisted by MM. Oudin and Barthélemy, has submitted to the Academy of Sciences several negatives of human limbs. One of them represented a diseased thigh-bone. The destroyed central portions had been penetrated by the light, forming white blotches on the plate. Another photograph was that of a tuberculous affection of the bone in a child's hand. The disease had been diagnosed, but photography brought complete confirmation to the diagnosis.

The Berlin correspondent of the *Lancet*, referring to the practical use being made of the discovery, says in one case a finger which had sustained a compound fracture, and from which a sequestrum had been removed, was photographed by the new process, and the regeneration of the bone was thereby made visible. In another case the position of a piece of glass embedded in the tissues was ascertained by the same method. Similar reports come from other Universities, as, for instance, from Berne, where Prof. Kocher has photographed a needle in a woman's hand; it had made its way under the skin some time ago, and had not been found by any other means.

A CONTRIBUTION TO THE NEW PHOTOGRAPHY.

NUMEROUS pictures are now being taken by means of the new method. The accompanying illustration, which we owe to the kindness of Prof. Nernst, and the original of which was made by him in the Physical-chemical Laboratory at Göttingen, represents a human hand as



photographed by means of the Röntgen rays. It will be seen that the flesh is very nearly transparent for these rays, while the bones, the gold ring, the piece of wire, and the glass tube are practically opaque. The ring and wire, which were naturally in contact with the flesh of the fingers, appear in the illustration as if suspended in the air

WILLIAM J. S. LOCKYER.

NOTES.

M. MOISSAN has been elected President of the Chemical Society of Paris.

M. ROUCHÉ has been elected Académicien libre of the Paris Academy of Sciences, in the place of the late Baron Larrey.

MR. ALEXANDER AGASSIZ, having finished his surveys of the coral-formations in the West Indies, has made arrangements to explore the Great Barrier Reef of Australia, and proposes to leave America for Brisbane, for that purpose, with a staff of assistants, early in March next.

THE valuable conchological collection formed by the late Miss Jane Saul, was bequeathed by her to the University of Cambridge, and has lately been received by the Museum of Zoology. The collection is principally remarkable for the magnificent series of the genus *Cypræa*, in which are included several species of great rarity.

OUR U.S. correspondent writes: "The announcement was made last August, that the New York Botanical Garden had received 250,000 dols. of the 500,000 dols. necessary to start it properly. Progress is now reported in raising the remaining 250,000 dols., Mrs. Esther Herrman, of New York, having contributed 5000 dols. Miss Helen Gould, sister of Countess Castellane, has given Vassar College 8000 dols. to endow a scholarship. Mr. Abram Abraham, of Brooklyn, recently empowered the President of Cornell University to purchase the Oriental library of Ernest Rénan as a gift to the University, but news has just been received that the widow of Rénan's publisher has given the library to the Bibliothèque Nationale. It is announced that the electrical exhibition to be held at New York, May 4–June 1, will be the most elaborate ever held in America. Barnard College, one of the new colleges for women, has recently raised a fund sufficient to secure it a permanent home, and will erect a $500,000 building next spring, on the corner of 119th Street and Boulevard New York, near the new site of Columbia College, with which Barnard is affiliated."

THE *Pharmaceutical Journal* states that a Committee has been appointed by Prof. Alfred Dohme, Chairman of the Scientific Section of the American Pharmaceutical Association, to direct investigations in the pharmacognosy, chemistry, biology, histology, &c., of drugs. The Committee consists of Prof. A. B. Prescott, of Ann Arbor, President; Prof. Edward Kremers, University of Wisconsin; Prof. L. E. Sayre, University of Kansas; Prof. John U. Lloyd, President of the Cincinnati College of Pharmacy; Prof. Samuel P. Sadtler, Philadelphia College of Pharmacy; and Dr. Charles Rice, Chairman of the National Committee on the Revision of the United States Pharmacopœia.

A NEW immense domain, full of interest for the naturalist and the anthropologist, is now opened for scientific exploration by the great Trans-Siberian railway. Last month the rails were laid on this line as far as Krasnoyarsk, on the Yenisei, and next summer the explorer will be able to reach by rail the banks of the Yenisei, at a distance of 3057 miles from St. Petersburg. With the cheapness of railway communication in Russia—a second-class return ticket from St. Petersburg to Omsk (2673 miles) costs about eight pounds—and the facilities opened for navigation by the great rivers running northwards, Siberia is sure to become soon a favourite field for scientific explorers.

SOME information concerning the Russian geological expedition which visited Novaya Zemlya last summer, was given by the geologist, M. Tchernyscheff, at the meeting of the Russian Geographical Society on January 2, and at the Mineralogical Society on January 8. The Matochkin Shar, which divides the great island into two parts, was visited, but could not be explored over its full length, on account of the ice stocked in its eastern portion. The expedition crossed Novaya Zemlya in the latitude of Karmakuly, and returned laden with rich geological collections. Undoubted proofs have been found of the secular raising of, at least, the southern island of Novaya Zemlya. This island is built up of Palæozoic rocks (Devonian and the "Artinsk" strata), which are covered with Post-Tertiary deposits. It bears traces of a wide glaciation which was followed by submergence, as shown by several beach-terraces, wide deltas, and lakes. At the present time it is in a period of upheaval.

UPON application of the Middlesex County Council the Home Secretary has made the following order, dated January 29: 1. "The Wild Birds Protection Act, 1880," shall apply within the county of Middlesex to the wryneck (cuckoo's mate or snake bird), swallow, martin (2), swift, bearded tit (reedling or reed pheasant), shrikes, kestrel, merlin, hobby, buzzard, honey buzzard, osprey, and magpie, as if those species were included in the schedule to the said Act. 2. The taking or destroying of the eggs of the following wild birds is prohibited within the county of Middlesex, viz. nightingale, goldfinch, lark, nightjar, woodpeckers, kingfisher, cuckoo, owls, kestrel, buzzard, honey buzzard, merlin, hobby, osprey, wryneck (cuckoo's mate or snake bird), swallow, martins (2), swift, bearded tit (reedling or reed pheasant), shrikes, magpie, wheatear, stonechat, whinchat, red start, fly catchers, sedge warbler, reed warbler, blackcap, garden warbler, wood warbler, willow warbler, chiff-chaff, white throat, lesser white throat, long-tailed tit, nuthatch, wren, gold-crested wren, wagtails (4), hawfinch, linnet, buntings (3), starling, landrail or corncrake, and coot.

PROF. IRA REMSEN describes in *Science* an interesting case of the accumulation of marsh gas under ice. It appears that a number of skaters were on a large artificial lake upon which remarkably clear ice had formed. In various places white spots were noticed in the ice, suggesting air-bubbles. Some one bored a hole through one of these white places, and applied a flame to the gas, which took fire. This led to further experiments, and it was found that, by boring a small hole, a long thin jet of flame could be obtained, and this continued for some time. The gas was marsh gas, formed by the decomposition of the vegetable matter at the bottom of the lake. Prof. Remsen remarks that this method of demonstrating the formation of marsh gas in nature is, from the æsthetic point of view, a great improvement on the usual method described in text-books, which consists in stirring a pool of stagnant water with a stick, and collecting the gas that rises to the surface. He suggests skating ponds illuminated by natural gas as among the possibilities of the future.

THE occurrence of a second period of very high barometric pressure in these islands during the month of January is noteworthy. The *Daily Weather Report* of the 28th showed that an anticyclonic area was spreading over the south-west of England, and at 11 p.m. on the 29th the high reading of 30·96 was recorded at Roche's Point, in the south of Ireland, and readings reached or exceeded 30·9 inches all over the south-western portions of England and Ireland. In London a maximum of 30·93 inches was reached, which corresponded with the reading there on the 9th of the same month. Such high readings have not occurred there since January 18, 1882 (when the barometer rose to 30·975 inches), and have been extremely rare during the last century. A peculiar feature of this high barometric pressure has been the

mildness and dampness of the weather; although some rather low temperatures were recorded by thermometers exposed to the sky, the maximum readings have reached 45° to 50° during the day-time. It will be remembered that this period last year was one of almost continuous, severe frost, which lasted until February 20.

IT was pointed out, in a recent article in the *Engineer*, that the introduction of warlike stores, and their final inspection and sentence, is entirely in the hands of naval and military men. The matter is again referred to in the current number of our contemporary as follows: "The actual manufacture only is under a civilian Director-General, but, with the exception of the Small Arms Factory at Enfield, the superintendents and their assistants were still all naval or military officers, and have remained so since the reorganisation carried out by an officer of the artillery in 1887. A colonel of artillery and two captains of the same arm manage the Royal Laboratory; a captain of the Navy and a lieutenant manage the Royal Gun Factory; a colonel of engineers is responsible for the Royal Carriage Department; a colonel of artillery, a captain, and a lieutenant, are responsible for the Royal Gunpowder Factory; and a colonel of artillery manages the factory in Birmingham. The Director-General has two military assistants, one a commander in the Navy, and one a captain in the artillery, and it would thus appear that he is assisted by no less than twelve officers of the Army and Navy, and therefore if the work turned out to be bad and dear—as it is alleged to be by the writers in the *Times*—that circumstance seems to us to be a strong argument in favour of the proposition that military and naval men are unfit, from want of technical knowledge and special training as manufacturers, to carry on manufacturing operations, and confirms the view which we have expressed of the imprudence of placing important factories under such management, and thus severely hampering a competent civilian Director-General. . . . In our judgment no substantial improvement in economical management is to be looked for till there is a complete separation between the military advisers of the Director-General and the civil assistants who are charged with the actual carrying out of the work and the keeping of the accounts."

THE question of the relation of psychology to physiology, and of the line of demarcation between the two sciences, is discussed by Prof. G. S. Fullerton in the *Psychological Review* for January. Psychologists are often charged with occupying themselves in doing work which is purely physiological, and they retort by stating that most text-books of physiology include matter which belongs to psychology. The fundamental assumption of psychology is, to state Prof. Fullerton's argument, the assumption of an external physical world, and of minds which mirror it. It is the task of the psychologist, with the aid of introspection, observation and experiment, to obtain a knowledge of such minds, and to reduce their phenomena to laws. Though little is known about the changes in a nerve during a passage of a nervous impulse, the methods employed in investigating physical and chemical problems may be expected to throw some light upon them. On the other hand, argues Prof. Fullerton, psychical facts—such as sensations, perceptions, volitions—have also to be reckoned with, and one would hardly expect to study them just as the changes in a muscle during contraction are studied. Therefore he thinks that while the task of the physiologist is to investigate, by directly objective methods, the physical series of causes and effects, the psychologist studies facts of another order by the method of introspection, observation and experiment, and interpretation.

IN a recent note we congratulated those interested in astronomy upon the fact that there would be soon a total solar eclipse visible almost at our doors, and that the Orient Company, Messrs. Cook, and Messrs. Gaze were advertising special steamers to go to Norway for the benefit of would-be observers. Then we went on to say: "We notice with some astonishment, in a circular issued by Messrs. Gaze and Son, the statement that 'an official party of observers, arranged by a joint committee of the Royal Society and of the Astronomical Society, are proceeding to Norway, and will travel by the s.s. *Norse King*.' We hardly think that this statement is authoritative, for scientific committees are not in the habit of advertising their intention to patronise any particular line of steamers; and, further, astronomers usually require more than five days to adjust and set up their instruments if any work of real use to science is to be done." We have received a letter from Messrs. Gaze and Son complaining that the above paragraph is "inaccurate," and assuring us that "an official party will travel by the *Norse King*." We willingly comply with their request, pointing out at the same time that we have been guilty of no inaccuracy, and that we did not deny their statement. We are not in a position to do so because, so far as we know, the Committee has published nothing on the subject. What we said was that it was not *authoritative*, and a statement of the kind made in an advertisement cannot surely be taken as authoritative even when it is used as a decoy. In any case we trust the "official party," whether singular or plural, will have a good time; but we still hold to our opinion as to the too short interval allowed for the preliminary arrangements on the spot.

MANY attacks have been made on the six zoological regions of Sclater and Wallace, and one of the most determined of these has been the proposal of an "Holarctic" region, to embrace the circumpolar districts and adjoining lands of both hemispheres. Dr. Scharff is a supporter of this view, which has likewise been maintained with great vigour by Dr. Merriam in America. But Dr. Wallace has shown that all the facts brought forward in its favour may easily be reconciled with the more orthodox view. An essay, entitled "Étude sur les Mammifères de la Région Holarctique et leurs relations avec ceux des Regions voisines," by Dr. R. F. Scharff, has just been published as an excerpt from the *Mémoires* of the French Zoological Society. In the essay, which has been rewarded by a prize founded at the International Zoological Congress held at Moscow, Dr. Scharff commences by a discussion of the Mammal-fauna of Ireland, and traces the species now existing and recently extinct in that country to their places of origin, so far as these can be settled by geological evidence. He proceeds to Southern Europe and Northern Africa, and shows how the Mammals that now inhabit these portions of the Palæarctic region may have reached their present quarters. There is much information to be gathered from the facts brought together by Dr. Scharff, but we cannot say that he has carried the case in favour of the "Holarctic" region much further than previous supporters of that theory.

THE number just issued of the *Arbeiten aus dem Kaiserlichen Gesundheitsamte* contains an official report by Regierungsrath Dr. Rahts, on the outbreak of influenza which occurred in Germany during the winter of 1893–94. In this epidemic, the country population suffered far more severely than that of the towns, and it is interesting to note that Hamburg experienced an exceptionally light visitation of the disease, this being doubtless partly attributable to the cholera epidemic of the previous year having eliminated to a certain extent the less vigorous lives. The period of incubation appears to have varied from two to five days, and the infectious nature of influenza was again amply verified. It is pointed out that the careful disinfection of all catarrhal expectoration is of great importance in preventing the

spread of the contagion, and the successful manner in which outbreaks were restricted is ascribed to such disinfection having been carried out on the same lines as those laid down in the case of tuberculous infectious material. On the whole the report does not throw any important fresh light on this mysterious disease, and its latest appearance in epidemic form does not appear to have differed very materially from that which has characterised previous outbreaks. No reference is made to the bacteriology of influenza.

AN important and most elaborately conducted inquiry has recently been made by Dr. Lösener on the opportunity for spreading disease offered by the burial instead of cremation of infected carcases. The actual conditions attending the process of burial were as far as possible faithfully followed, both as regards the depth of the hole and the enclosure of the carcase. The duration of vitality of the various pathogenic microbes under such circumstances was found to vary very considerably. Thus typhoid bacilli only on one occasion survived the processes of putrefaction 96 days, cholera vibrios could not be detected after 28 days, tubercle bacilli lived from 95 to 123 days. Tetanus bacilli were, however, still in a highly virulent condition even after 234 days, but after the lapse of 361 days they were no longer discoverable. The bacillus pyocyaneus lived up to 33 days, and Friedländer's pneumonia bacillus 28 days; whilst anthrax germs retained their full complement of virulence during the whole year over which the investigations extended. As regards infection of the surroundings, the information is so far satisfactory, inasmuch as only in the case of anthrax germs were they discovered to have found their way to the adjacent soil and water. So admirable a barrier, however, is provided by the soil, that the earth close beneath the bottom of the hole containing the infected carcase, was in every case found to be quite devoid of pathogenic germs. The bacterial purification effected by filtration through soil has been shown by the Massachusetts experiments on sewage in which five feet of garden soil and five feet of peat were respectively used. So few microbes found their way through, that they were not attributable to the filtration itself, but rather to post-filtration sources. Of course for practical filtration purposes these materials are not available, as they work so very slowly, but the results obtained with them help to support Dr. Lösener in his reassuring views as to the hygienic aspects of burial.

A PAPER of considerable interest, contributed by Dr. F. Ahlborn to the current number of one of our best-known contemporaries, contains a novel application of rowing to biology (*Zeit. f. wiss. Zool.*, lxi., December 1895). The main object of the paper is to explain the use and meaning of the asymmetrical types of tail-fin which are so commonly met with among fishes—*e.g.* the upturned tail of the shark and sturgeon, and the downwardly extended fin of the flying-fish. Dr. Ahlborn's explanation is founded on a recent suggestion of Prof. F. E. Schulze's in regard to the tail of Ichthyosaurus, and is illustrated by comparisons presumably drawn from the author's own experiences in the art of rowing. Every tyro knows the consequences which ensue if he holds his blade too obliquely in the water. If the upper edge is inclined too much towards the stern of the boat, a brisk pull upon the handle results in the blade jumping out of the water, and the oarsman falling backwards from his seat; if, on the other hand, the blade is inclined too much in the opposite direction, it digs into the water and the oarsman "catches a crab." The relevance of these illustrations is found in the fact that the skeletal support of the asymmetrical tails of fishes is generally such that either the upper or lower border of the fin is more resistant to the pressure of the water than the opposite border, a fact which causes the fin in action to assume an oblique, instead of a vertical position. The result of such a disposition is that in those cases where the upper part of the tail is stiffer than the lower the tail in locomotion is driven upwards, as the oar is driven out of the water (heterocercal tail of shark and sturgeon); while in cases where the lower part of the tail is firmer than the upper the tail tends, in action, to assume a lower position than the rest of the body (flying-fish). The body of the animal, in fact, is made to swing vertically about a horizontal axis running through the centre of gravity: in the first group the tail becomes elevated above the head, in the second group the head becomes raised above the tail. The utility of these types of organisation becomes obvious when we reflect, with Dr. Ahlborn, upon the habits of the creatures which exhibit them. The first group consists of bottom-haunting fish, which are thus enabled to give free play to their tails while scouring the sea-bottom in search of food; the second consists entirely of surface-swimming forms which are enabled, by this beautiful adaptation of structure, to swim swiftly beneath the surface of the water without the risk of their tails emerging, and so causing inconvenience and waste of force. The tails of many air-breathing aquatic animals, such as the crocodile, water-snake, and the extinct Ichthyosaurus, are constructed upon this latter principle.

THE number of the *Trinidad Field-Naturalists' Club* for October 1895, contains an elaborate paper by Mr. T. I. Potter, on four species of *Oncidium*, natives of the island.

THE Field Columbian Museum has commenced the issue of a series of botanical papers, with a contribution to the Flora of Yucatan, by Mr. C. F. Millspaugh, botanical curator, illustrated by several photographs. The orders which are most numerously represented in the Peninsula are the Leguminosæ and the Compositæ.

ATTRACTIVE, but somewhat belated, are the Brochures 3 and 4 of vol ii. of the *Proceedings* of the Rochester Academy of Science, just received by us. The papers contained in these publications were, for the most part, read before the Society in 1893. Among the subjects treated are: "The Evolution of the Ungulate Mammals," by Prof. H. L. Fairchild; "Solar Electrical Energy not transmitted by Radiation" by Dr. M. A. Veeder; and "The Pitch Lake of Trinidad," by Mr. A. Cronise.

THE editor of *Just's Botanischer Jahresbericht* has issued an appeal to all botanists for a prompt despatch of separate copies of their contributions to scientific journals, or other botanical treatises. The average number of such papers, an abstract of which is given in each year's *Bericht*, is about 5300; and of these the editor has never received, up to the present time, copies of more than 300. The papers should be addressed to the Editor, Prof. Dr. E. Koehne, Kirchstrasse 5, Friedenau-Berlin.

VOL. iii. No. 6 of the Contributions from the *U.S. National Herbarium* consists of an interesting account of the botany of Yakutat Bay, Alaska, by F. V. Coville, to which is prefixed a general report on the characteristics of the Flora, by F. Funston. Even in August the danger in crossing the bay in canoes is very great from the floating ice. The country is largely covered by impenetrable forests of the Sitka spruce, *Picea sitchensis*. The number of species of vascular plants gathered was 137, the predominant orders being Ranunculaceæ, Rosaceæ, Compositæ, and Gramineæ.

Bulletin No. 9 of the "Minnesota Botanical Studies" for 1895 contains an interesting article, by Mr. R. W. Squires, on Tree-temperatures. The observations were made between

January and June on a specimen of *Acer Negundo*. During the whole of this period the temperature of the tree was lower than that of the air in the morning and at noon, but higher in the evening. The lowest temperature of the tree recorded was in February, $-21^{\circ}\cdot1$ C. In the same part Miss H. G. Fox gives a monograph of the species of *Cypripedium* belonging to the Atlantic region of North America, six in number, with a scheme of the affinities of all the American species of the genus.

THE fourth volume of the *Transactions* of the Royal Society of Victoria (1895, pp. 166) is taken up with "A Monograph of the Tertiary Polyzoa of Victoria," by the late Dr. MacGillivray. The monograph is illustrated by twenty-two lithographed plates, all of which were prepared by Dr. MacGillivray, but only a few pages of the descriptive text had been written, and Prof. Baldwin Spencer and Mr. T. S. Hall are responsible for the descriptions required to complete it. In Victoria, as well as in South Australia, there are numerous Tertiary formations containing large deposits of Polyzoa, the accurate determination of which, especially in relation to the living species, is of great geological interest. Dr. MacGillivray's monograph, with its numerous fine illustrations of species, will prove of great assistance in working out this relation.

THE second volume on "Africa," in the new issue of Stanford's Compendium of Geography and Travel, deals with South Africa, and the author is Mr. A. H. Keane. The volume is not merely an enlarged edition of Keith Johnston's work, but practically a new publication, containing but a few passages of the original text, while only three of the old text-figures have been retained. Nnmerous new and carefully selected illustrations give attractiveness to the text, which is well abreast of the knowledge of African geography. How enormously the available information has increased may be gathered from the fact that the present volume, dealing with South Africa alone, runs into 671 pages; and we can quite believe Mr. Keane when he says: "Occurrences of far-reaching consequence have followed in such swift succession that in the preparation of this work the chief difficulty has been to keep pace with the shifting scenes." A broad view is taken of geography, attention being given to African history, political questions, and ethnology, as well as to the physical features, hydrography, and natural history of the continent. Altogether the volume is a valuable addition to the works dealing with Africa, and a desirable acquisition to every geographer's library.

THE first volume of what promises to be a very elaborate "Traité de Chirurgie clinique et opératoire," has come to us from MM. J. B. Baillière et Fils. The editors of the work, which will be completed in ten bulky volumes, are Profs. A. Le Dentu and P. Delbet; and if the first volume, dealing with general and special pathology, is followed by others of like fulness and quality, a valuable work of reference will have been added to the literature of surgery. The chief object of the editors—the object towards which the efforts of all physicians and surgeons tend—will be to make the publication the *livre de chevet* of those who are concerned with the origin and treatment of diseases. It is the surgery of to-day that will be expounded, not that of the past. The recent conquests in the domain of anatomy, bacteriology with all its applications to therapeutical surgery, and operative methods which have extended the field of action of surgery, will all be fully dealt with. Such a broad scope, when considered by the side of the distinguished men who have undertaken to write the various sections, is sufficient to establish the work in a high position.

IN a paper in the current number of the *Berichte* (January 13) by Lobry de Bruyn and A. van Ehenstein, further details are given of the properties of free hydrazine, NH_2—NH_2. In the first preliminary communication by M. Lobry de Bruyn, two methods of obtaining the anhydrous base were described, viz., by the action of barium oxide upon hydrazine hydrate, and by the reaction between sodium methylate and hydrazine hydrochloride in absolute methyl alcohol; in either case the hydrazine being separated by fractional distillation under reduced pressure. Free hydrazine is a liquid which at 23° has a density of 1·003, and on cooling with ice solidifies to a crystalline mass melting at $1^{\circ}\cdot4$ C. Unlike free hydroxylamine, which is explosive, hydrazine is a very stable body, boiling unchanged under ordinary atmospheric pressure at $113^{\circ}\cdot5$ C., and not decomposing at a temperature of 300°. In its chemical behaviour the free base resembles the hydrate, being oxidised to nitrogen by oxygen or air, and converting solid sulphur into hydrogen sulphide on warming. In a subsequent note in the same journal, by M. Lobry de Bruyn, an improved method is given for the preparation of hydrazine hydrate in quantity, advantage being taken of the fact that glass is not attacked by this substance at temperatures under 50° C. Since the hydrate boils at 47° under a pressure of 26 mm., the fractional distillation, if conducted at pressures below this, may be carried out in glass vessels.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. Edmund Sheriff; a Common Boa (*Boa constrictor*) from Trinidad, presented by Mr. S. A. Cumberland; a —— Antelope (*Cervicapra*) from Africa, a Kinkajou (*Cercoleptes caudivolvulus*) from South America, a Cormorant (*Phalacrocorax carbo*), British, two Samoan Fruit Pigeons (*Ptilonopus apicalis*) from Samoa, deposited; a Sharp-nosed Snake (*Passerita mycterizans*) from India, purchased.

OUR ASTRONOMICAL COLUMN.

ECLIPSES IN FEBRUARY.—During the present month there will be an annular eclipse of the sun and a partial eclipse of the moon. The former will occur on February 13, but as the path of the annulus lies wholly in the South Atlantic and Antarctic Oceans, it is of little interest. At the Cape of Good Hope it will be visible as a partial eclipse, magnitude 0·849, the greatest phase occurring at 6h. 38m. Cape mean time, that is, sixteen minutes before sunset.

The more important phases of the partial eclipse of the moon on February 28 will be visible in this country, provided the weather be favourable. The following particulars for Greenwich are from the *Companion to the Observatory*:—

	h. m.			h. m.
First contact with penumbra	5 15·5	...	With shadow	6 16·3
Last ,, ,,	10 15·9	...	,, ,,	9 15·1

First contact with shadow takes place at an angle of 85° from the north point towards the east, and the last contact at 30° towards the west. The magnitude of the eclipse (moon's diameter = 1) will be 0·870. The moon will rise at 5h. 27m.

During the partial eclipse the following stars will be occulted:

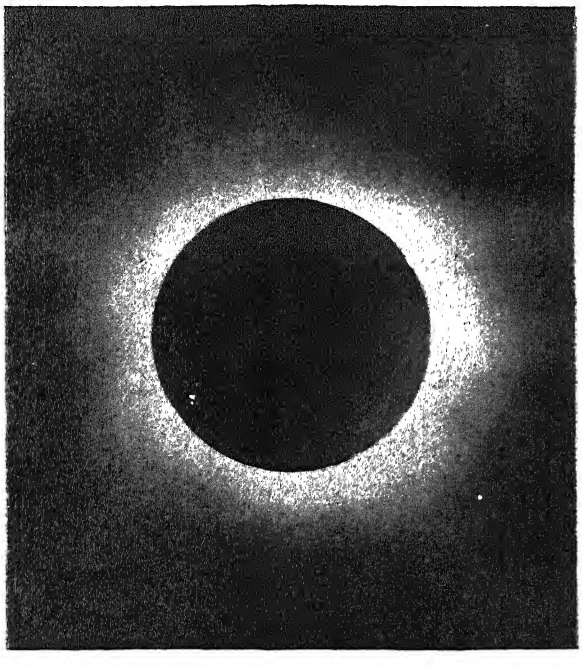
Star.	Mag.	Disappearance or Reappearance.	G.M.T.	Angle E. of N.
			h. m.	
B.D. +7·2373	9·3	D	6 42	81
+6·2364	8·8	D	7 6	147
+7·2370	9·5	R	7 7	325
+7·2373	9·3	R	7 28	334
+7·2364	8·8	R	7 56	270

ASTROPHYSICAL STANDARDS.—The need for greater uniformity in standards, &c., has long been felt by all engaged in astrophysical researches, and we learn with pleasure that the Editorial Board of the *Astrophysical Journal* has taken up the matter. As the result of a circular addressed to the Associate Editors, the following decisions have been arrived at, and an

appeal is made for their general adoption. Rowland's scale of wave-lengths, as represented by the tables in course of publication in the journal above named, is to be employed, and the unit of wave-length is to be the ten-millionth of a millimetre, or "tenth-metre." For measurements of velocity in the line of sight, the kilometre is to be taken as the unit. To distinguish the lines of hydrogen, the nomenclature starting with H_α in the red and continuing in alphabetical order through the entire series is agreed upon. Maps of spectra are to be drawn with the red end to the right, and tables of wave-length are to be printed with the shorter wave-lengths at the top.

Although some of the leading workers in astrophysics have not been consulted, it is probable that these arrangements, so far as they go, will meet with general approbation. It is to be regretted, however, that the representation of intensities of spectrum lines was not considered, as a scale which every one might be willing to adopt is, perhaps, even more urgently required than any general agreement on the points to which reference is made above.

REPRODUCTION OF ASTRONOMICAL PHOTOGRAPHS.—The Council of the Royal Astronomical Society has lately undertaken the reproduction (by paper prints and lantern slides) of a selection of the instructive astronomical photographs in the possession of the Society. The prints and lantern slides are sold to Fellows of the Society at approximately cost-price, and full details as regard subject, instrumental data, exposure, &c., are given upon each. Among the celestial pictures which have been thus rendered available to a wider circle of astronomers, are



photographs of total solar eclipses of 1886, 1889, and 1893, Dr. Roberts' photographs of the Pleiades and the Great Nebula in Orion, Prof. Barnard's photographs of the Milky Way, and of Brooks' and Swift's comets, Dr. Gill's photograph of the nebula about η Argûs, and MM. Loewy and Puiseux's lunar photographs. The accompanying illustration of the eclipse of April 16, 1893, has been reduced by one-third from a print sold by the Society. The original was taken by Sergt.-Major Kearney, R.E., at Fiundium, West Africa, with a Dallmeyer photoheliograph, the exposure being twenty seconds.

HOLMES' COMET.—Prof. Barnard has just published an account of his observations and photographs of this comet, made during its appearance in 1892 and 1893 (*Astrophysical Journal*, vol. iii. No. 1). Some of the telescopic features appear to have been quite unique. On January 4, 1893, only a feeble glow was visible; twelve days later it seemed like a hazy star, and the nucleus was actually seen to brighten in the few hours of observation, while the body itself expanded; six days afterwards, the nucleus had almost disappeared again. A photograph taken on November 10, 1892, is chiefly remarkable as showing a large irregular mass of nebulosity covering an area of at least a square degree, and connected with the comet by a short hazy tail. This curious appendage, which certainly belonged to the comet, seems to have been overlooked by most observers, but its recognition may possibly at some time or other prove to be of importance. The facts seem to be in favour of the comet having suddenly become bright just before the time of its discovery. It differed from the average comet in having a nearly circular orbit, and unless there had been some great change in its path, or some internal change, it should have been discovered long before. As the comet could not be seen with the Lick telescope during the succeeding opposition, Prof. Barnard thinks that it no longer exists in the cometary form, and will never be seen again.

THE LIQUEFACTION OF AIR AND RESEARCH AT LOW TEMPERATURES.[1]

THE best and most economical plant for the production of liquid air or oxygen is one based on the general principle of that used by Pictet in 1878, for liquefying oxygen; instead, however, of using Pictet's combined circuits of liquid sulphur dioxide and carbon dioxide kept in circulation by compression, liquefaction and exhaustion, it is better to employ ethylene in one circuit, as Cailletet and Wroblewski did, and to use nitrous oxide, or preferably carbon dioxide, in another. Further, instead of causing the oxygen to compress itself during its formation from potassium chlorate heated in an iron bomb connected with the refrigerator, it is found convenient to use gas previously compressed in steel cylinders.

A very convenient laboratory apparatus, the arrangements of the circuits of which will be easily understood from the sectional view shown in Fig. 1, has been devised for the liquefaction of small quantities of oxygen or other gases; with this simple arrangement, 100 c.c. of liquid oxygen can readily be obtained, using liquid carbon dioxide at − 79° C. for cooling and employing no exhaustion. The gaseous oxygen, cooled before expansion by passing through a spiral of copper tube immersed in solid carbon dioxide, passes through a fine screw stopcock under a pressure of 100 atmos., and thence backwards over the coils of pipe. The liquid oxygen begins to drop in about a quarter of an hour from starting. The pressure in the oxygen cylinders at starting is generally about 150 atmos., and the best results are got by working down to about 100. This little apparatus will enable liquid oxygen to be used for demonstration and research in all laboratories.

By employing jacketed glass vessels, of which the annular space is highly exhausted, for storing liquefied gases, the influx of heat is reduced to one-fifth of that which occurs when the jacket contains air; if the interior walls are silvered, or excess of mercury vapour is left in the jacket, the influx of heat is again reduced to one-sixth, so that the total effect of the high vacuum and the silvering is to reduce the ingoing heat to about 3½ per cent. of that which enters when these precautions are neglected. The suggestion that the metallic coating is useless, because Pictet has found that all kinds of matter are transparent to heat at low temperatures, is thus disposed of; further, no increase in the transparency of glass to thermal radiation occurs on cooling to the boiling point of air.

In order to test Olszewski's statement that air cannot be solidified at the lowest pressures (*Phil. Mag.*, February 1895), the author's former experiments have been repeated on a larger scale. If a litre of liquid air be exhausted in a silvered vacuum vessel, half a litre of solid air may be obtained and kept solid for half an hour. The solid is at first a stiff transparent jelly, which, when placed in a magnetic field, has the still liquid oxygen drawn out to the poles, showing that solid air is a nitrogen-jelly containing liquid oxygen. Solid air can only be examined in a vacuum or an atmosphere of hydrogen, because it instantly melts on exposure to the air, causing an additional quantity of air to liquefy; it is strange to see a mass of solid air melting in contact with the atmosphere, and all the time welling up like a fountain.

On causing dry air, contained in sealed flasks, to solidify by

[1] A paper read before the Chemical Society on December 19, 1895, by Prof. J. Dewar, F.R.S. (Abridged from the *Proceedings* of the Society issued January 14.)

immersing the side arms attached to the flasks in liquid air boiling under a low pressure, and subsequently hermetically sealing off the side arms containing the solid, the residual air left in the flasks may be preserved for analysis; it is then ascertained that the residual air still contains oxygen and nitrogen in the usual proportion. In the earlier experiments, the argon solidified before the nitrogen, but chemical nitrogen and air nitrogen with

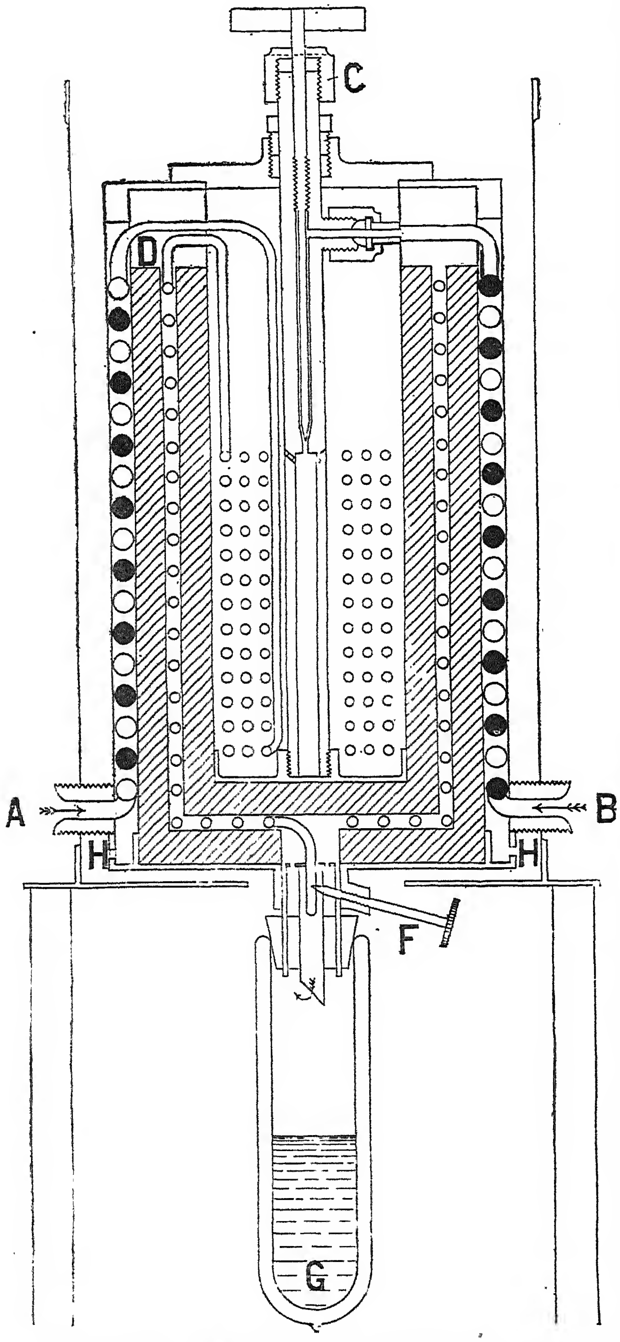


FIG. 1.—A, air or oxygen inlet. B, carbon dioxide valve. D, regenerator coils. F, air or oxygen expansion valve. G, vacuum vessel with liquid oxygen. H, carbon dioxide and air outlet. ○, air coil. ● carbon dioxide coil.

its 1·1 per cent. of argon behaved in substantially the same way on liquefaction.

Olszewski has examined liquid nitric oxide, and describes it as colourless, but on strongly cooling several carefully purified samples of this gas, which had been prepared by different methods, the author obtained in each case a nearly white solid melting to a blue liquid. The colour is more marked at the melting than at the boiling point, and the liquid is not magnetic. Solid nitric oxide is not phosphorescent, nor does it show any chemical action in liquid oxygen, provided the tube containing it is completely immersed; but if the tube full of liquid oxygen be lifted into the air, a violent explosion almost instantly occurs.

In a good vacuum vessel, specific gravities may be taken in liquid oxygen as easily as in water. Some twenty substances were weighed in liquid oxygen, and the apparent density of the liquid calculated; the results were then corrected, using Fizeau's values for the variation of the coefficients of expansion of the solids employed, and the real density of liquid oxygen was thus calculated as 1·1375 under a pressure of 766·5 m.m. The variation of density is about $\pm$ 0·0012 for 20 m.m. pressure. Wroblewski found the density of liquid oxygen at the boiling point to be 1·168, whilst Olszewski found 1·124. Fizeau's parabolic law for the variation of the coefficient of expansion holds down to $-183°$; the solid which contracted least during cooling was a compressed cylinder of silver iodide, that which contracted most a block of compressed iodine.

Similarly the density of liquid air was found to be 0·910 and that of nitrogen at its boiling point 0·850. No great accuracy attaches to the density of liquid air as thus determined, for liquid air kept in a silvered vacuum vessel rises 1° in boiling point every ten minutes during the first hour; the density of

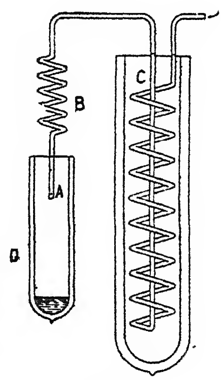


FIG. 2.

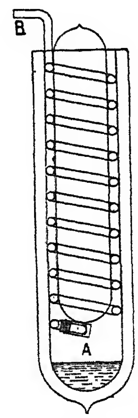


FIG. 3.

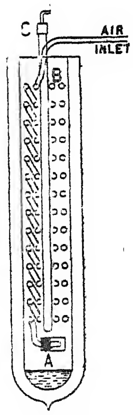


FIG. 4.

liquid air, however, does not reach that of pure oxygen even after thirty hours' storage.

A small ignited jet of hydrogen burns continuously below the surface of liquid oxygen, all the water produced being carried away as snow. There is a considerable amount of ozone formed, which concentrates as the liquid oxygen evaporates. In the same way graphite, or diamond, when properly ignited, burns continuously on the surface of liquid oxygen, producing solid carbonic acid and generating ozone. If liquid oxygen is absorbed in wood charcoal, or cotton wool, and a part of the body heated to redness, combustion can start with explosive violence.

The experiments of Joule and Thomson and Regnault on the temperature of gas jets issuing under low pressures are well known; the following observations refer to the pressure required to produce a lowering of temperature sufficient to yield liquid in the gas jet. The apparatus used in the study of highly compressed gas jets is sketched in Fig. 2; C is a vacuum tube holding a coil of pipe about 5 mm. in diameter along with carbon dioxide or liquid air for cooling the gas before expansion, and A is a small hole in the silver or copper tube about $\frac{1}{5}$ mm. in diameter, which takes the place of a stopcock. When carbon dioxide gas, at a pressure of 30 or 40 atmos., is expanded through such an aperture, liquid can be seen where the jet impinges on the wall of the vacuum tube along with a considerable amount of solid. If oxygen gas escapes from the small hole at the pressure of 100 atmos., having been cooled previously to $-79°$ in the vessel C, a liquid jet is just visible. It is interesting to note in passing that Pictet could get no liquid oxygen just below 270 atmos., owing to his stopcock being massive and outside the re-

frigerator. If the oxygen is replaced by air, no liquid jet can be seen unless the pressure is raised to 180 atmos. If the carbon dioxide is cooled by exhaustion (to about 1 in. pressure) or $-115°$, liquid air can easily be collected in the small vacuum vessel D, or if the air pressure is raised above 200 atmos., keeping the cooling at $-79°$ as before. The chief difficulty is in collecting the liquid, owing to the rapid current of gas. The amount of liquid in the gas jet is small, and its collection is greatly facilitated by directing the spray on to a part of the metallic tube above the little hole, or by increasing resistance to the escaping gas by placing some few turns of the tube, like B in the figure, in the upper part of the vacuum tube, or generally by pushing in more tube in any form. For better isolation, the pipe can be rolled between two vacuum tubes, the outer one being about nine inches long and one and a half inches diameter, as shown in Fig. 3; the aperture in the metal pipe has a small piece of glass tube over it, to help the collection of the liquid. Using this apparatus and an air supply at 200 atmos. with no previous cooling, liquid air begins to collect in about five minutes, but the liquid jet can be seen in two to three minutes. In Fig. 4 the metallic tube in the vacuum vessel is placed in horizontal rings, leaving a central tube for the passage of the glass tube C, which is used to cool bodies or examine gases under compression; the inner tube can be filled for an inch with liquid air at 60 atmos. pressure, in about three minutes. A double coil of pipe may be advantageously used in some experiments; the efficiency is low, but it affords a quick method of reaching low temperatures and collecting a few hundred cubic centimetres of liquid air. By the use of this apparatus air at the ordinary temperature can be simply converted into liquid air at the boiling point, $-194°$, in less than ten minutes; a fall of 200° is effected in this short period of time.

The author, after giving a sketch of the results up to the present achieved in connection with the liquefaction of hydrogen, remarks that hydrogen, cooled to $-194°$ (80° abs. t), the boiling point of air, is still at a temperature which is two and a half times its critical temperature, and its direct liquefaction at this point would be comparable to that of air taken at 60°, and liquefied by the apparatus just described. Now, air supplied at such a high temperature greatly increases the difficulty and the time required for liquefaction. Still, it can be done, even with the air supply at 100°, in the course of seven minutes; and this is the best proof that hydrogen, if placed under really analogous conditions, at $-194°$ must also liquefy with the same form of apparatus. Hydrogen, cooled to $-200°$, was forced through a fine nozzle under 140 atmos. pressure, and yet no liquid jet could be seen. If the hydrogen contained a few per cent. of oxygen the gas jet was visible, and the liquid collected, which was chiefly oxygen, contained hydrogen in solution, the gas given off for some time being explosive.

If, however, hydrogen, previously cooled by a bath of boiling air, is allowed to expand at 200 atmos. over a regenerative coil similar to that shown in Fig. 2, but longer, a liquid jet can be seen after the circulation has continued for a few minutes along with a liquid which is in rapid rotation in the lower part of the vacuum vessel. The liquid did not accumulate, owing to its low specific gravity and the rapid current of gas. These difficulties will doubtless be overcome by the use of a differently shaped vacuum vessel and by better isolation. The liquid jet can, however, be used as a cooling agent, like the spray of liquid air obtained under similar circumstances, and, this being practicable, the only difficulty is one of expense. In order to test in the first instance what the hydrogen jet could do in the production of lower temperatures, liquid air and oxygen were placed in the lower part of the vacuum tube just covering the jet. The result was that in a few minutes about 50 c.c. of the respective liquids were transformed into hard white solids resembling avalanche snow, quite different in appearance from the jelly-like mass of solid air got by the use of the air pump. The solid oxygen had a pale, bluish colour, showing by reflection all the absorption bands of the liquid. There is no reason, apart from that of cost, why a spray of liquid hydrogen, at its boiling point in an open vacuum vessel, should not be used as a cooling agent in order to study the properties of matter at some 20° or 30° above the absolute zero.

The only widely distributed element which has not yet been liquefied is fluorine; and it would seem that, although the atomic weight of fluorine is nineteen times that of hydrogen, it must in the free state approach hydrogen in volatility. If the chemical energy of fluorine is abolished at low temperatures, like that of other active substances, some kind of glass or transparent substance, less brittle than calcium fluoride, could be employed in the form of a tube, and the liquefaction of fluorine achieved by the use of hydrogen as a cooling agent.

SCIENCE IN THE MAGAZINES.

POLITICS saturates the February magazines, but science is not altogether drowned in this plethora of diplomatic diatribes. There are four articles in the *Contemporary* of interest to scientific readers. Mr. Herbert Spencer traces the development of the sculptor, and shows how, in its primitive character, sculpture was an auxiliary to ancestor-worship. "The tomb and the temple are," he shows, "developed out of the shelter for the grave—rude and transitory at first, but eventually becoming refined and permanent; while the statue, which is the nucleus of the temple, is an elaborated and finished form of the original effigy placed on the grave. The implication is that, as with the temple so with the statue, the priest, when not himself the executant, as he is among savages, remains always the director of the executant—the man whose injunctions the sculptor carries out." Mr. W. H. Hudson writes pleasantly, if somewhat aimlessly, about the village of Selborne and of the simple naturalist whose observations have made it famous. Mr. W. H. Mallock continues his study of "Physics and Sociology." The argument of the two articles which preceded the present one may be thus summarised: Great men are analogous to atoms of superior size, on whose presence the aggregation of all the other atoms depend, therefore they should form the first study of the sociologist. Two propositions (among others) which follow from this conclusion are now stated by Mr. Mallock; the first of them being more or less of a heresy, so far as scientific opinion is concerned. The propositions are as follows. (1) Other things being equal, communities progress and become civilised not in proportion to the talents of the mass of the individuals who compose them, but in proportion to the percentage which occurs in each of the individuals whose talents are superior to those of the mass. (2) Other things being equal, communities progress and become civilised in proportion to the desirability of the rewards which are practically attainable in each by the exercise of superior talents, and which thus stimulate the possessors of these talents to develop them, and make them actual instead of merely potential. Mr. D. C. Boulger having suffered from diphtheria, and been made a victim of the anti-toxin treatment, survived, and now records his experience of the disagreeable character of the disease and its sequelæ, all of which unpleasantness was aggravated, in his opinion, by the employment of antitoxic serum. From his particular case, he passes to a general discussion of diphtheria and antitoxin, which he condemns. So few are the gifts to science and education in England, that we rejoice to find Mr. Bernard Shaw commending in the *Contemporary* such benefactions to the attention of millionaires. The questions which a millionaire, moved by a generous spirit to benefit any locality, should ask himself are: "Has it a school, with scholarships for the endowment of research, and the attraction of rising talent at the universities? Has it a library, or a museum? If not, then he has an opening at once for his ten thousand or hundred thousand pounds."

"Reflex Action, Instinct, and Reason" are discussed from the point of view of their development in the *Fortnightly* by Mr. G. A. Reid. It suffices here to call attention to the article, which is a chapter from a forthcoming book on "The Present Evolution of Man," and to state the definitions of instinct and reason given in it. Instinct is defined as "the faculty which is concerned in the conscious adaptation of means to ends," by virtue of inborn inherited knowledge and ways of thinking and acting. Reason is defined as "the faculty which is concerned in the conscious adaptation of means to ends" by virtue of acquired non-inherited knowledge and ways of thinking and acting. An admirable article on "Plant Names" appears in the *Quarterly Review* (January), being a review of the "Index Kewensis" and of four other recent publications upon the names of plants. In the *National*, Mr. Walter B. Harris describes Tiflis, the capital of Transcaucasia, and in *Scribner* an interesting account is given of an ascent of Mount Ararat, the paper being illustrated by several of the finest specimens of process-work we have ever seen.

Knowledge contains articles on curious facts in plant distribution, by Mr. W. B. Hemsley, F.R.S.; waves, by Mr. Vaughan Cornish; Antarctic exploration, by Mr. W. S. Bruce; and comets of short period, by Mr. W. E. Plummer. There is also a full-page reproduction of Dr. Roberts' photograph of the nebula near 15 Monocerotis. We omitted to mention that in the January number, Dr. H. R. Mill had an article on "Geography as a Science in England," in which he pleaded for a more scientific study of geography.

Longman's Magazine has an excellent short article on the Pasteur Institute, by Mrs. Frankland. Mr. H. M. Stanley tells "The Story of the Development of Africa" in the *Century*. Among the subjects lightly and brightly treated in *Chambers's Journal* are left-handedness, by Dr. R. A. Lundie; turpentine farms in Georgia; Bath brick; new work on the filtration of water; and flint-knapping. Dr. Andrew Wilson writes on Medusæ in the *English Illustrated*. A description of the fantastic forms taken by lycopodium powder or a semi-liquid substance, when placed upon a flexible membrane set vibrating by the voice, is given by Margaret W. Hughes in *Good Words*, under the title of "Voice Figures." The article is illustrated by reproductions of some of the beautiful patterns thus produced. An article entitled "The Romance of the Museums," in the *Strand Magazine*, contains a short description, with illustration, of the Cranborne meteorite, in the British Museum Collection. The same magazine has in it a short story of adventure, founded upon the action of the "Souffleur" at Port Gorey, Sark. The scientific interest of the story lies in the section which is given of the Gouliot Caves, in order to explain how "Souffleurs" are caused.

THE CONSTITUTION OF SCIENTIFIC SOCIETIES.[1]

SOME cultivators of the sciences occasionally complain that the meetings of scientific bodies are not well attended, and that they read papers to too many empty benches. Moreover, even when they have a scientific audience they allege that very few of those present understand what they have to say. And they speculate on measures to be adopted to remedy this state of affairs.

As the scientific investigator acquires years and experience, he recognises that in the present state of human society he has no right to expect that the situation can be very different. The number of serious cultivators of science in any community is not large, and the number of men engaged in original research in any given field is still smaller. Like the landed aristocracy of the old nations, the producers in each department of science are well scattered over a country, and it is only on national occasions that they gather in any considerable force. The situation as to the audiences who assemble to listen to papers of original value in pure science is therefore not likely to change for some years. In fact, the size of audiences may be set down as inversely as the rationality, and directly as the emotionality of the matter set before them. Such is the present state of the civilised nations of the earth, and it is not peculiar to any one of them.

Most of the large cities of the United States have an "Academy of Sciences," or its equivalent, and it is largely with reference to the prosperity of those bodies that discussions such as we have referred to above is heard. Many of the members want them to be what they call popular, which, in its best sense, means that they wish for large audiences at the meetings. Now, if what we have said above is true, this object cannot be attained unless the academy abandons its real object, the advancement of scientific knowledge by original research. This is the primary object of academies of science in all countries, and if they neglect it, they lose their identity, since the facilities for the distribution of knowledge are everywhere relatively abundant. When the academy of science becomes a distributor of knowledge only, it abandons its important proper function, and becomes comparatively a nonentity. Let us hope that academies of science in America will not follow the course of the academies of music, which are, in Europe, educational and critical, in America, mere theatres.

The measures adopted by academies of science in the United States to make themselves popular and therefore "successful," are often highly amusing. The usual method is to elect some man president who is rich but unknown to science; since, in the minds of some people, money is the source of the sciences and the arts. Men of the same type are also often elected to other responsible positions in these societies for similar reasons. We have watched this mode of attacking the problem for many years, and have never known it to be successful. In the case of the Philadelphia Academy, it did, on one occasion, entail a loss of over $12,000 cash capital to the Society. In fact, the reasons why this method should not prove successful are not far to seek. The only way to make it successful would be to have a bill of sale of the office legally executed, so that the sum agreed on could be collected by process of law in case of failure to produce the "consideration" after the election. This the business world understands, whereas it does not perceive the cash value of original research. In fact, the election of an outsider to rule over them by a body of experts for a supposed financial equivalent, is a proceeding not calculated to excite the respect of a rich man or any other kind of man.

A society is, however, fortunate if it escapes without more serious injury than a financial disappointment. Men not habituated to the ways and means of research frequently apply nostrums which do more harm than good, and bring the society into deserved contempt. Thus in one city the president, who was of the type mentioned, succeeded in incorporating into the society a body of photographers, with the result of simply developing the photographic society. The men by whom the original society was known to the world were locally quite lost sight of. In another city a number of local amateur astronomical clubs were taken into the academy. These consisted of ladies and gentlemen whose devotion to science consisted in viewing the stars in each others pleasant society. Another academy adopted popular lectures as a device for filling empty benches. The selection of the lectures being in the hands of incompetent officers, cranky and ignorant persons, and those who had apparatus to sell, occupied the time of the academy, to the great scandal of the really scientific men of the city.

The appointment of amateurs and unscientific persons to positions in scientific bodies, often has ludicrous results. One academy of science discussed an ancient bone dredged up in salt water. It was perforated with fossæ in series, and it was concluded that it was a mouth bone of a fossil fish. It turned out to be the head of an ancient tooth-brush. An exhibition of foot-tracks on ancient rocks before the same academy, brought to his feet a dancing-master, who illustrated the formation of the impressions terpsichorean fashion.

Another plan for promoting the prosperity of scientific bodies is to have dinners and social receptions. These methods are always successful in drawing together numbers, and if persons are to be elected members of such societies in proportion to their gastronomic capacities, such a system must be eminently successful. To be serious, however, and to repeat what should be self-evident to every person, this plan tends only to an increase of non-expert membership, which is really at the bottom of all the evils which have befallen scientific societies. Hence, unless some measures to protect the membership be adopted, this method of "promotion" should be always rejected.

The result, both of our observations and cogitations on this subject, is that the only method by which academies of science can advance themselves in the public esteem, is to continue in their work of original research. If they cannot acquire public confidence in this way, they cannot acquire it at all. There is no short-cut to this so-called "success." As in all other human endeavours to wrest advantage from nature, labour and labour only "omnia vincit." As with the agriculturist, the machinist, or the accumulator of money, devotion to work, and this only, brings the rewards which we seek. The visible products of labour are what men respect, and if the scientific man wishes to inspire the respect of wealth, he must show results, rather than bestow on men of wealth what are to them empty honours.

[1] Reprinted from the *American Naturalist*, December 1895.

SCHOLARSHIP SCHEMES OF TECHNICAL EDUCATION COMMITTEES.

ONE of the chief ways in which Technical Education Committees all over the country spend the funds entrusted to them is in the award of scholarships; and if this branch of their work is wisely organised and carried out, there is no better method of securing the proper education of promising boys and girls. The scholarships awarded can be divided into four classes, namely, those tenable at (1) Technical Schools and Science and Art Schools; (2) Secondary Schools; (3) Universities or institutions of University rank; (4) short courses of instruction. Full information

with reference to these scholarships has appeared at various times in the *Record* of Technical and Secondary Education. An examination of the particulars there given reveals several interesting facts, not the least among which is the diversity of opinion as to what the candidates for such exhibitions and scholarships should be examined in. At Plymouth, boys are expected only to have a knowledge of sixth and seventh standard work when they enter for scholarships of the first of the above divisions, while those of Bristol are set papers not only in elementary subjects, but also in algebra, Euclid, French, German, chemistry, botany, &c. Candidates in Blackburn and Stockport, amongst numerous other places, are set papers in the subjects of the "Science and Art Directory," though in the former place any commercial knowledge proves useful, and at Stockport boys may enter themselves for any branch of technology mentioned in the City and Guilds' programme. Such facts as these show that we are yet far removed from any definite and uniform course of education graduating from the elementary school upwards. The complaints, which are published in most of the County Council reports, of the hopelessness of looking for any satisfactory progress in technical instruction until the students entering technical or science and art schools are better prepared to benefit by their teaching, are likely to be often repeated unless it is made compulsory upon all scholarship holders to give satisfactory evidence of their acquaintance with, at least, the work of the elementary schools. In some cases, authorities have tried to avoid this difficulty by stipulating that candidates shall have been pupils in elementary schools; but it is notorious that a year or two after leaving school most boys have completely lost any knowledge they may have had. Means by which the continuity of a boy's education may be ensured have yet to be taken. No permanent gain can result if technical work is built on insecure foundations, and we imagine that the foundations of scientific knowledge can be very properly begun in the elementary school. This knowledge should be carried on in evening continuation schools, and attendance at such schools should be made compulsory, as it is in Germany. If that were done, a boy at the age of seventeen would be in fit condition to enter the true technical school, whereas, under the present system of elementary education, he is not. The want of agreement to which we have referred obtains also when we come to consider the conditions under which scholarships to secondary schools are awarded. The most striking feature here is perhaps the countenance which is given to dabbling in all sorts of subjects. Since the secondary school is, as a rule, intended for boys from about thirteen to sixteen or seventeen years, and is, or should be, entered at, or about, the lower age, it seems unreasonable to expect any candidate to have done anything of importance at such subjects as botany and physiology, and yet such subjects are continually asked for. At every point one is struck with the want of coordination in the various grades of English education. If we could once get something like a consensus of opinion as to the proper work of the elementary, the secondary, the technical school, and finally of the college, this continual difficulty of what to examine in would not arise. When we come to look into the regulations affecting the scholarships offered by the technical instruction committees at universities or institutions of university rank, it becomes painfully evident that such committees are by no means clear what their work properly is. Several county authorities consider a knowledge of Latin, and one at least recognises familiarity with Greek, as being desirable for technical students. It is not our desire to decry the study of the classics, but we maintain that neither Greek nor Latin gives any claim to a technical scholarship, and, further, that the grant for technical education is being wrongly used if it is awarded for proficiency in such subjects. It cannot be too much insisted upon that one of the points which the advisers and directors of the various committees need yet to consider, refers to the requirements and capacities of the different classes of the community, and how these can best be met.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The lecture list for the current Term contains a few features of interest. In the Department of Medicine Dr. J. Ritchie gives a practical course of Elementary Morbid Histology, making use for the first time of the pathological laboratory which has recently been fitted up in the Department of the Regius Professor of Medicine.

Mr. J. C. Alsop is assisting the Professor of Experimental Philosophy in practical instruction, and Mr. E. W. A. Walker is assisting in the practical course of Physiology in the Department of Physiology. Otherwise the courses of lectures in the Faculties of Medicine and of Natural Science are unchanged.

An examination for a Radcliffe Travelling Fellowship will be held during the present term, commencing on March 3. Intending candidates, who must declare that they intend to devote themselves to the study of Medical Science during the tenure of the Fellowship, and travel abroad with a view to that study, are required to send their names and qualifications to the Radcliffe Examiners, the Radcliffe Library, Oxford, on or before February 3.

Mr. W. Warde Fowler, Fellow of Lincoln College, has been appointed a Curator of the Botanic Garden, in place of Mr. Edward Chapman, Fellow of Magdalen College, resigned.

The Delegacy of Non-Collegiate Students announce that a Shute Scholarship of an annual value of £50 will be awarded on Saturday, June 20. The examination will be in Chemistry, and will commence on Tuesday, June 2. The Scholarship is open, and there is no limitation of age; but no member of the University will be eligible, who shall have completed eight Terms from the date of matriculation.

CAMBRIDGE.—The Council of the Senate have appointed Mr. Charles Smith, Master of Sidney Sussex College, Vice-Chancellor, a Governor of Eton College, in the room of Dr. Forsyth, F.R.S., who has resigned.

The subscribers to the Robertson Smith Memorial have paid over to the University £335 for the purchase of Oriental manuscripts, after investing some £1100 for the maintenance in Christ's College of the late Professor's library.

The memorial respecting degrees for women, signed by over 2000 members of the Senate, has been presented to the Council. The discussion of the subject by means of fly-sheets and pamphlets has already begun, and promises to be unusually keen.

At the matriculation on January 28, twenty-seven new names were added to the list of freshmen; this raises the total entry up to the present to 938.

ON Friday, January 31, the Duke of Devonshire distributed certificates to the scholars and exhibitioners elected last year by the Technical Education Board of the London County Council. There were 5 senior county scholars, 60 intermediate county scholars, 600 junior county scholars, 135 art scholars and exhibitioners, and 73 evening science exhibitioners, making a total of 882. What the scholarship scheme of the Board is, and what it aims at doing, will be gathered from the following remarks made by the Duke of Devonshire. In the first place there are the junior county scholarships, open to boys and girls under thirteen years of age, by competition. These scholarships carry with them free education in a secondary selected school for two years, and a money payment divided between the two years of £20. The examination by which they are gained is an examination in the subjects taught in elementary schools. Thus, the advantage of two years of education beyond the age of thirteen in a higher school is opened up to a large number without any cost to themselves or to their parents. It is the first step upon the educational ladder which has been set up by the County Council, and whether that step is taken as a preliminary to an attempt to rise to higher rungs of that ladder, or whether it is taken with no object of prosecuting the ascent higher, yet the advantage of these two added years of education in an efficient selected school may prove and ought to prove of immense value to the student. The next step in this ladder is a grant of a smaller number of intermediate county scholarships, which enable boys and girls under the age of sixteen to continue their education further in secondary schools up to nineteen, and of course carrying with them a higher money payment to compensate for the higher value of the labour which it is the object of this scheme to make during the period of education necessary; and, finally, the County Council offer a limited number of still higher scholarships which will enable the fittest of those who have distinguished themselves in previous competitions to continue their education for three years in either a college or some other institution of University rank. What, in fact, the County Council, through its Technical Board, has been able to do has been to establish something in the nature of a technical

University for the county of London, although the County Council itself has not assumed any such ambitious denomination for its work. On the contrary, continued the Duke, the Technical Education Board is fully aware of the need of our great metropolis for a teaching University, and it has promised to that new University a contribution of £10,000 a year, contingent upon the organisation of that body being such as will secure the advantages of a new University to all classes of the inhabitants of London, including the artisan and the labouring classes. The Council has thus shown the most practical proof that in its opinion the great work which it has already undertaken still requires to be supplemented by something more thoroughly and more completely deserving the name of University education for the county of London.

WE learn from the *Times* that Mr. T. H. Ismay has written to the President of the Liverpool Engineering Society, offering on behalf of the White Star Line Company the sum of £2000, to be used in founding and maintaining in connection with University College a scholarship intended to perpetuate the memory of the late Sir Edward Harland and his association with the shipping life and engineering profession of Liverpool. It is proposed that the scholarship shall be awarded for nautical engineering and marine architecture, and called the "Sir Edward Harland Memorial Scholarship."

THE following new announcements of gifts to educational institutions in America are noted in *Science*. Mr. J. H. Armstrong, of Plattsburg, deeded a considerable property to Union College, but retained a life interest in it. On January 2 of this year he died, and by his will added to the gift, which now amounts to 100,000 dols. The Legislature of Massachusetts has passed the Bill granting 25,000 dols. to the Massachusetts Institute of Technology. Mrs. Josiah N. Fiske has given Barnard College 5000 dols. for the foundation of a scholarship which will be open to competition.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for January 1896, contains but one article—on the development of *Asterina gibbosa*, by E. W. MacBride, Fellow of St. John's College, with plates 18-29. The investigations forming the subject of this memoir were commenced some years ago; the author at first intended to work out the development of the so-called heart, with its accompanying sinuses, in the Asterids, as he had previously done in the case of the Ophiurids. Coming to the conclusion, however, that our knowledge of the development of most of the organs in the Asterid body was very defective, he determined to thoroughly revise their whole history, embryonic and larval. This work has occupied his attention for the last two years, and as a result we have this carefully written memoir, which the author hopes may be found to place our knowledge of Asterid development on the same level as that to which our acquaintance with Crinoid ontogeny has been raised by the researches, among others, of Bury and Seeliger. The material was chiefly collected at the Naples Station. The memoir is prefixed by a statement of the methods of research adopted, and concludes with a chapter entitled "General Considerations," in which two questions are asked: (1) What light does this history throw on the affinities of the Asterids with the other Echinoderms? and (2) Does it suggest any direction in which we may look to find the origin of the group Echinodermata? The answer given to the former is that the Asterids have an affinity with the Crinoids, and that they had a fixed ancestor; and to the latter, that assuming a free-swimming ancestor of Echinoderms (provisionally called Dipleurula), it and the Tornaria ancestor of Balanoglossus must have been closely allied. This further involves the assumption that the Asterids were thus allied to the Protochordata.

THE number of the *Nuovo Giornale Botanico Italiano* for January contains, among others, the following papers:—Botanical results of a journey to the Lower Obi, by S. Sommier.—A paper by A. Pizzigoni on the dry and moist cancer of the potato, which he regards as two distinct diseases; the former due to the attacks of *Fusisporium solani* alone, the latter to this fungus, together with bacteria.—Sig. G. Del Guercio describes the changes produced in the cortex of the oak by the attacks of the larva of *Gracilaria simploniella*.—Prof. A. Borzì has a paper on the hydrophorous apparatus of xerophilous plants belonging to the Mediterranean flora; those specially described are the nodal sheath and cushion of many Caryophylleæ, the leaf-sheath of Gramineæ and Umbelliferæ, and the ochrea of Polygonaceæ.—Sig. A. Lenticchia contributes a useful list of the flowering plants of Italian Switzerland.

IN the *Bullettino* of the Italian Botanical Society for December 1895 and January 1896, are papers on the dimorphism in the flowers of *Convolvulus arvensis*, caused by the attacks of *Thecaphora hyalina*.—On the meteorology of the year 1895, and its effects on the plants in the Botanic Garden at Florence. The lowest temperature recorded during the severe winter 1894-95 was -7° C.—On the biology of the flowers of *Oxalis cernua*, with especial reference to the occurrence of fertile flowers intermediate between the normal and the true cleistogamous flowers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 5, 1895.—"The Measurement of High Potential Difference." By H. C. Leake, R. Leventhorpe, and C. S. Whitehead.

This paper describes firstly the method adopted by Prof. Ayrton and Mr. Mather for the accurate calibration of electrostatic voltmeters in electro-magnetic units. For this purpose a high alternating potential difference is employed, which can be measured by the apparatus in several ways, each of which is a check on the others. By means of a divided resistance and a new type of low-reading idiostatic electrometer, the high alternating potential difference can be measured without involving determinations of either current or resistance. It is probable that the measurements of 2000 volts are correct to about $\frac{1}{10}$ per cent. in terms of the Clark cell.

With the aid of this apparatus, and the most probable value of "v," the authors determined the accuracy with which measurements of steady potential differences of about 2000 volts could be made in terms of the absolute electrostatic unit by means of the Kelvin absolute electrometer, when used in the ordinary way, and they found that measurements made with this instrument were always too large by, on the average, $1\frac{1}{2}$ per cent.

They traced this error to imperfection in the action of the coach-springs, the greater part of which could be eliminated by keeping the springs constantly loaded.

The remaining error, which was due to change of temperature of the coach-springs, was reduced by very carefully shielding the instrument from heat when in use, and was finally eliminated by the use of a simple correction formula. This method of correction had the great advantage of not depending on thermometer readings, as the coach-springs themselves were virtually used as a metallic thermometer to indicate their own temperature.

With these precautions it was found possible on some occasions to make measurements with the absolute electrometer accurate in absolute electrostatic units to about $\frac{1}{10}$ per cent., in so far as the authors were able to judge; but it was found that on many days there was an error of about $\frac{1}{2}$ per cent. in the constant of the instrument, due to some inherent defect, intermittent in its action, which could not be satisfactorily explained.

A theoretical investigation is given to determine the most suitable values of the mass to be used for the initial adjustment of the coach-springs, and of the potential difference to which the electrometer should be charged, for the heterostatic measurement of a given potential difference, with the result that the former should be proportional to the $\frac{3}{2}$ power, and the latter to the first power of the potential difference to be measured. It is also shown that, in addition to the well-known advantages of the heterostatic over the idiostatic method, there is the additional advantage that the error in the ordinary assumption as to the value of the effective area of the attracted disk is of far less importance in the former than in the latter method.

Finally an investigation is given in which Schwarz's method is applied to determine the error in the ordinary assumption as to the value of the effective area, for the case when the disk and guard-ring are not quite in the same plane.

Geological Society, January 8.—Dr. Henry Woodward, F.R.S., President, in the chair.—A delimitation of the Cenomanian, being a comparison of the corresponding beds in Southern England and Western France, by A. J. Jukes-Browne and William Hill. The object of the authors has been to compare the beds which form the lower part of the Upper Cre-

taceous series in those parts of Southern England and Western France which are nearest to one another. They claim to have defined the limits of the Cenomanian stage in Western France, and to have shown that this group of beds is simply a southern extension of our Lower Chalk, formed in a shallower part of the Cretaceous Sea and nearer to a coast-line.—The Llandovery and associated rocks of Conway, by G. L. Elles and E. M. R. Wood, Newnham College. In the paper a full description of the representatives of the Birkhill, Gala (Tarannon), and Wenlock beds was given, and the distribution of the fossils (chiefly graptolites) in the various subdivisions was recorded. Many of the graptolites are forms which had been described from Swedish deposits, but had hitherto been unrecorded in this country.—The gypsum deposits of Nottinghamshire and Derbyshire, by A. T. Metcalfe. The gypsum deposits of these counties occur in the Upper Marls of the Keuper division of the Triassic system. The author described their occurrence in thick nodular irregular beds, large spheroidal masses, and lenticular intercalations, and their association with satin-spar, alabaster, selenite, and anhydrite.

EDINBURGH.

Royal Society, January 6.—The Hon. Lord M'Laren in the chair.—Dr. Buchan submitted a paper on the high temperatures of September, and the Ben Nevis observatories. He described briefly the weather of September generally, which was markedly anticyclonic, and selected for consideration the 28th, 29th, and 30th of the month, as being characteristic in an intensified degree. On these days, the state of the atmosphere at Fort William, and low levels in Scotland generally, was one of great humidity. On the top of the mountain, on the other hand, there was great dryness. It was the opinion of Prof. Tait, and other physicists whom he had asked, that when the vapour in the atmosphere existed as pure vapour, it was practically diatherminous to the sun's rays. Between the (reduced) barometer at the top of the mountain, and the barometer at Fort William with a temperature difference of four degrees, there was only a difference of half a tenth, while the calculated difference for such a difference in temperature should have been a hundredth. He considered this inquiry to be of value in the prediction of storms. —Dr. Knott read a paper on the strain produced in iron and nickel tubes in the magnetic field. He described the apparatus used, and the numerous difficulties to be overcome, and exhibited graphs of the volume-changes of the tubes. He had found the behaviour of steel tubes so extraordinary that he reserved it for further treatment.—Prof. Tait described some further work he had done in the study of the path of a rotating spherical projectile. From the equations involved he had deduced the paths which such a moving body should follow, and, though some of these looked extraordinary, being concave *upwards*, and even looped, he was not without hopes of reaching them in practice. He had already succeeded in the case of some of them, with a teetotum.

DUBLIN.

Royal Dublin Society, December 18, 1895.—Prof. A. C. Haddon in the chair.—Mr. A. Francis Dixon read a paper on the development of the branches of the fifth cranial nerve in man. The paper was illustrated by models of the fifth cranial nerve in five different stages of the human embryo.—Prof. Grenville A. J. Cole read a paper on the rhyolites of County Antrim, with a note on bauxite. These rocks, often spoken of as "trachytes," occur as isolated exposures among basalts. At Templepatrick, rhyolite is seen to be intrusive in the Lower Basalts; but elsewhere the junctions are quite obscure. The author believes that there is not justification for the construction of sections showing the supposed relations of the rocks; but he urges that the mass at Tardree Mountain is very complex, and he calls special attention to the extensive flows of fluidal, perlitic, and spherulitic lavas at Sandy Braes. The various rocks are described in detail, and a survey of this area suggests that the pale bauxites of Co. Antrim have been derived from the decomposition of the rhyolites. Soluble salts of aluminium may have been formed throughout the lavas by the action of solfataras, &c.; waters containing alkali-carbonates may have acted on these, causing the precipitation of the basic aluminium carbonate studied by MM. Urbain and Renoul; and the extreme instability of this compound may have given rise to aluminium hydrate, which would be washed down into lakes during the interval between the outpouring of the Lower and Upper Basalts, together with the iron oxide also found in bauxite. At Ballycloughan, north of Ballymena, a distinctly biotitic rhyolite occurs as an intrusive neck; and at Cloughwater there is a patch of most delicately fluidal character; both these have vertical flow-planes. The rhyolites of Co. Antrim are often poor in ferro-magnesian minerals, but soda-pyroxene is common at Carnearny and on Sandy Braes.—Prof. James Lyon described a system of hot-water supply for domestic purposes. In the case of hot-water supply by means of domestic boiler and circulating cylinder, in order to obviate the necessity for drawing off a quantity of cold water from the rising pipe before the hot water can be obtained, the rising pipe is often returned near the bottom of cylinder to produce circulation. When this is done a flap valve of special construction should be placed at the latter point, to prevent cold water supply from flowing from bottom of cylinder, and thus mingling with the hot water which is being drawn.

PARIS.

Academy of Sciences, January 27.—M. Cornu in the chair.—On the equilibrium of an elastic body, by M. H. Poincaré.—Of the utility of photography by the X-rays in human pathology, by MM. Lannelongue, Barthélemy, and Oudin. In diseases in which there is an actual loss of substance of the bone, or an abnormal growth of bony tissue, the photographs taken by the Röntgen method confirm the previous diagnosis.—On a non-linear differential equation of the second order with doubly periodic coefficients, by M. Hugo-Gyldén. A particular solution of an equation of importance in astronomy. Application is made of the solution to the planet Hilda (153) with a satisfactory result.—Biological studies on some Hirudinia, by M. A. Kowalevsky.—On the linear equations and the method of Laplace, by M. E. Goursat.—On the addition of the arguments in the periodic functions of the second order, by M. G. Fontené.—On the complete solutions of the equation

$$x_1 \tan^{-1}\frac{1}{\kappa} + x_2 \tan^{-1}\frac{1}{\kappa_2} + \ldots + x_n \tan^{-1}\frac{1}{\kappa_n} = k \cdot \frac{\pi}{4},$$

by M. Carl Stormer.—On certain invariants relating to a group of Hesse, by M. Boulanger.—On groups of operations, by M. Levasseur.—Theory of pitching on a rolling sea, by M. A. Kriloff.—Some properties of the Röntgen rays, by M. Jean Perrin. The conclusion is drawn that these rays are not identical with the kathodic rays, since the latter cannot pass out through vacuum tube walls of 1 mm. in thickness. The propagation of the Röntgen rays is shown experimentally to be linear; they are not reflected either by a mirror of polished steel or of glass, neither are they refracted by prisms of paraffin or wax. Unsuccessful attempts to form diffraction fringes showed that if the phenomenon is periodic, the period is much below that of green light.—Observations on the preceding communication by M. Poincaré, pointing out that Prof. Röntgen has already shown that the X-rays are not refracted.—Dark light, by M. Gustave Le Bon. An ordinary photographic dry plate, placed under a negative in a printing-frame, and the negative closely covered with a thin plate of iron, was exposed to the light of a paraffin lamp for three hours. Vigorous and prolonged development brought out a faint but well-defined image. If a plate of lead was wrapped round the back of the frame, and bent over the edges of the iron plate so as to enclose the printing-frame in a metallic box, after three hours' exposure to the same source of light an image was obtained "which was nearly as vigorous as if no obstacle had been interposed between the light and the plate." M. Le Bon proposes to continue the study of the properties of light after its passage through opaque bodies.—Action of heat on mercurous iodide, by M. Maurice François. To avoid the complications introduced by the presence of air, the mercurous iodide was heated *in vacuo*. The reaction is a limited one, equilibrium resulting when a fixed amount (depending on the temperature) of mercurous iodide has been broken up into mercury and mercuric iodide. Hence the reaction is reversible, and the same state of equilibrium results if mercury and mercuric iodide are taken and heated together.—The absorption of light by solutions of indophenols, by MM. Bayrac and Ch. Camichel. A quantitative study of the absorption spectra of homologous indophenols in various solvents. Relations are indicated between the positions of the absorption bands, concentrations, and molecular weights. One compound, obtained by the general method of preparation of indophenols from mono-methyl-resorcinol and *p*-nitroso-dimethyl-aniline hydrochloride, gives quite anomalous results, and hence the conclusion is drawn that this body is not an indophenol.—Combinations of aluminium chloride with phenols and

their derivatives, by M. G. Perrier.—On Russian essence of aniseed, by MM. G. Bouchardat and Tardy.—On the production of pure gaseous formic aldehyde, by M. A. Brochet. For the purposes of disinfection by gaseous formic aldehyde, free from water vapour, a current of a warm indifferent gas (nitrogen or carbon dioxide) is passed through a tube containing fragments of trioxymethylene. The quantity can be regulated by altering the temperature.—On antivenomous serum, by MM. Calmette, Hankin, and Lépinay. An account of some experiments with a serum, the injection of which protects the animal from snake venom.—On some points in the anatomy of *Tetraclita porosa*, by M. A. Gruvel.—New form of negative reaction on the retina, by M. Aug. Charpentier.—Proofs of the submarine extension to the south of Marseilles of the Maures and Esterel group, by MM. Vasseur and Fournier.

BERLIN.

Physical Society, December 13, 1895.—Prof. Warburg, President, in the chair.—The President referred to the deaths of Prof. Knoblauch, of Halle, and Prof. Spörer, of Potsdam.—Prof. Des Coudres spoke on kathodic radiation, and demonstrated its sensitiveness to magnetic lines of force.—Prof. Neesen described two interesting strokes of lightning, of which one pierced the roof of a church-tower unprovided with a conductor, and stopped short at the organ. Its effects were characterised by the rents it made in the inside of the church above the organ, similar to those observed in a tree when struck. The second struck a petroleum store, whose four tanks were each protected by five-pointed conductors adequately put to earth. Two of the tanks were completely shattered by a violent explosion, the other two burnt out by fire. The speaker was of opinion that the petroleum vapours above the tanks had been ignited by small sparks during the discharge, and he had verified this view by experiment; he therefore proposed that for the purpose of adequate protection all openings, more particularly manholes, should be guarded by wire netting, on the principle of the Davy lamp.—A small instrument was exhibited by Mr. von Hefner-Alteneck for demonstrating minute variations of atmospheric pressure. It consists of a flask, whose neck communicates with a horizontal glass tube, whose central portion is bent slightly downwards; in this tube there is an extremely mobile index of coloured petroleum, which follows the least change of external pressure. The apparatus is one hundred and fifty times more sensitive than a mercurial barometer.—Prof. Neesen criticised a recently published method of measuring the velocity of projectiles. It consists in making the projectile close and open a current which passes spirally round a tube containing carbon bisulphide; the plane of polarisation of this fluid is rotated during the time of flight, and hence a beam of light previously extinguished by crossed Nicols can now pass through, and make a record on photographic paper.

Physiological Society, December 6, 1895.—Prof. H. Munk, President, in the chair.—Prof. I. Munk reported on further experiments as to the minimal proteid requirements of a dog during nitrogenous equilibrium.

December 20.—Prof. H. Munk, President, in the chair.—Dr. Cohnstein reviewed the laws of osmotic pressure from the existing point of view of physical chemistry.—Dr. Rosenberg spoke on reported cases of presumed regeneration of the bile duct some twenty days after its extirpation. He reported a case of a lateral branch from the duct recently observed in a dog and leading into the intestine, and urged that the possible existence of such a branch should have been in every case disproved before concluding that a regeneration of the duct had taken place.—The President exhibited a section of an elephant's tooth, which showed a circular green streak round the outer border of the pulp cavity.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Eclipses du Soleil et Occultations: L. Cruls (Rio de Janeiro).—Le Climat de Rio de Janeiro: Ditto (Ditto).—Posicões Geographicas: Ditto (Ditto).—Iowa Geological Survey, Vol. 4 (Des Moines).—Ex-Meridian Altitude Tables: Brent, Walter, and Williams (Philip).—A Naturalist in Mid-Africa: J. F. Scott Elliot (Innes).—Domesticated Animals: N. S. Shaler (Smith, Elder).—Practical Studies in Fermentation: Dr. E. C. Hansen, translated by Dr. A. K. Miller (Spon).—Petroleum: B. Redwood, 2 vols. (Griffin).—Computation Rules and Logarithms: Prof. S. W. Holman (Macmillan).—Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History): The Wealden Flora: A. C. Seward, Part 2 (London).—Catalogue of the Fossil Fishes in the British Museum (Natural History): A. S. Woodward, Part 3 (London).—Roads and Pavements in France: A. P. Rockwell (Chapman).—Cyanide Processes: E. B. Wilson (Chapman).—Heating and Ventilating Buildings: Prof. R. C. Carpenter (Chapman).—Manual of Lithology: Prof. E. H. Williams, jun. (Chapman).—Vegetable Culture: A. Dean (Macmillan).—Lessons in Elementary Botany: T. H. MacBride (Boston, Mass., Allyn).—University Correspondence College Calendar, 1895-96 (Red Lion Square).—Catalogue of Scientific Papers (1874-1883), compiled by the Royal Society of London, Vol. xi. (C. J. Clay).

PAMPHLETS.—The Authentic Letters of Columbus: W. E. Curtis (Chicago).—Contribution to the Flora of Yucatan: C. F. Millspaugh (Chicago).—Variation of Latitude at New York City. Part 1: Declinations and Proper Motions of Fifty-six Stars: Dr. H. S. Davis (New York).—Shanghai Meteorological Society. Third Annual Report: Essay on the Winter Storms of the Coast of China: Rev. S. Chevalier (Shanghai).—Laboratory Tables for Qualitative Analysis (Manchester, Cornish).—Handbook and Catalogue of the Meteorite Collection: Dr. O. C. Farrington (Chicago).—The Honey-Bee: F. Benton (Washington).—Proceedings of the Seventh Annual Meeting of the Association of Economic Entomologists (Washington)

SERIALS.—Proceedings of the Academy of Natural Sciences of Philadelphia, 1895, Part 2 (Philadelphia).—Proceedings of the Rochester Academy of Science, Vol. 2, Parts 2 and 4 (Rochester, N.Y.).—Proceedings and Transactions of the Nova Scotian Institute of Science, Session 1893-94 (Halifax, Nova Scotia).—Zeitschrift für Physikalische Chemie. xix. Band, 1 Heft (Leipzig, Engelmann).—History of Mankind: F. Ratzel, translated (Macmillan).—Cassell's History of England, Part 1 (Cassell).—Humanitarian, February (Hutchinson).—Royal Gardens, Kew. Bulletin of Miscellaneous Information, 1895 (Eyre).—Proceedings of the Physical Society of London, Vol. 13, Part 13; Vol. 14, Part 1 (Taylor).—Contemporary Review, February (Isbister).—Terrestrial Magnetism, No. 1 (Chicago).—National Review, February (Arnold).—Fortnightly Review, February (Chapman).—American Journal of Mathematics, January (Baltimore).—Centralblatt für Anthropologie, &c., 1 Jahrg., Heft 1 (Williams).—Journal of the Chemical Society. December (Gurney).—Century Magazine, February (Macmillan).—Geographical Journal, February (Stanford).—Science Progress. February (Scientific Press).

CONTENTS.

THURSDAY, FEBRUARY 13, 1896.

POPULAR GEOLOGY.

Open-Air Studies: an Introduction to Geology Out-of-doors. With illustrations. By Prof. Grenville A. J. Cole, M.R.I.A., F.G.S., &c. Pp. viii + 322. (London: Griffin and Co., Limited, 1895.)

PROF. GRENVILLE COLE has already won himself wide repute as a writer on geological science by his book, entitled "Aids in Practical Geology" (Griffin and Co.). There Prof. Cole treated the branches of mineralogy, petrology, and palæontology, dwelling more particularly on methods of work in laboratory and museum. This recent publication, "Open-Air Studies," breathes another atmosphere, lighter, gayer, and for the popular mind more enticing. The Professor leads his readers, like a class of students, into one countryside after another, makes use in imagination of bicycle and railway on the low ground, ascends boldly into glacier-swept regions, and roams at will across moorland and highland Everywhere he directs their powers of observation, drills great facts into them by presenting particular aspects again and again as occasion offers. Now and then the Professor calls a halt to recapitulate, set in order, or give more careful demonstration of stratigraphical difficulties.

The "Open-Air Studies" are ten in number. The author gives the key-note in his preface: "In our walks abroad we may be struck by this or that detail, seemingly trivial in itself, which finally leads up to some one of the vexed problems of the globe." The first chapter gives some preliminary teaching on "The Materials of the Earth," the rock-forming minerals being carefully examined. It is not until chapter ii. that the author takes his pen into the "Open Air." We are told: "We must imagine that we wake up on a fine clear morning at the foot of some of our wild mountain-masses in the British Isles" (p. 28), and we are guided up a swirling stream, past pools and waterfalls, to "a mountain hollow." On our way, our professorial guide bids us do many simple things. We have to "dig for a little while with a walking-stick," that "we may be able to see the tiny streamlet flowing"; we have to note that the "loose blocks, half buried in the grass, are made of the same materials as the cliffs"; to watch how, if some one kicks a stone, "it goes bounding down across the grass, it leaps over one or two of the little cliffs, and so descends until it rests on some lower ledge of the hill-side" (p. 30). Then we put our fingers into pot-holes, and move the pebbles in them, and we watch the stream washing down its load of mud and pebble, and listen to its rattling stones.

In this manner the pleasant little object-lesson is continued, and the attentive follower is made to observe for himself the forces of denudation at work on a mountain-side. Arrived at the mountain-tarn, the Professor is beguiled by the endless questions which rise to our lips into delivering quite a learned lecture on nature's tools—cloudland; wind, dew, and rain; frost, ice, and snow; stream, glacier, and avalanche. In the midst of it, we find ourselves frequently transported to glaciated Alpine valleys. Cirques are described and explained, an illustration is given of a snow-filled cirque on the Matterhorn, and applied to the past history of our own mountain-hollows.

From the tenour of this chapter, which is a fair type, it will be seen that Prof. Cole limits the subject-matter of his new book to that contained in any ordinary elementary text-book of geology. Familiar truths are re-set, and any claim to originality or success rests entirely upon the workmanship and brilliancy of that re-setting.

If we rightly understand Prof. Cole's method, it is the antithesis of the analytic method practised by a text-book writer. The latter passes, as it were, the diffuse light of knowledge through his own prism-acting mind, and it appears on his manuscript as a fully-resolved spectrum in which every band of colour is clearly presented to the student. Prof. Cole's method, on the other hand, is to call upon each student to make his own mind the prism. Observations, massed together with all the local details of nature, are thrown upon the student's mind, which may or may not be fit to act on its own account as a clear prism. Theoretically the system is laudable, but decidedly unstable. The author himself succeeds in carrying it out only through about one-half of the 313 pages of "Open-Air Studies." Certainly half the chapters—i., vi., vii., viii., and x.—are really text-book studies, and these are, moreover, the most concise and complete in their treatment.

To proceed with the actual contents, chap. iii. is called "Down the Valley." Its central theme may be thus expressed, in the words of the author: "The story of all streams is alike—excavation at one end and deposition at the other; and the area of deposition extends slowly back up the valley as time goes on" (p. 80). A typical Tyrolese valley is made the main basis of observation. The cutting of deep gorges by torrential side-streams, the spreading-out of talus-cones at the mouth of tributary valleys, the "creep" of a hillside downwards, landslips, the occasional damming up of the stream and formation of a lake, the resulting wide agricultural flats where these become later silted up or drained—these and other features are described with copious reference to famous scenes and incidents in the Alps.

The river Rhine is studied between Chur and the Lake of Constance, to illustrate alluvial deposits and the variations which take place in the course of a river. A "delta" is defined, examples given, and brought home to us by the remark that "an enterprising child with a spade can soon produce a shallow lake, and can observe how it becomes filled and obliterated by the encroachment of a delta at its upper end" (p. 86).

The main discussion of deltas, however, falls into the following chapter, "Along the Shore." There, too, the first lessons on sedimentary deposits are given. The abrasion of a coast-line by the action of the waves, leads up to an explanation of Sir Andrew Ramsay's term "plain of marine denudation." The author then goes on to show how the worn-away material is reconstructed into different kinds of strata bedded beneath sea, lake, and river. Even deep-sea deposits of siliceous organisms, the growth of coral-reefs, and the formation of oolites find a place here, although the chapter begins and ends

with the description of a pretty fishing-village, low cliffs, and a coastguard station!

Chapter v., "Across the Plains," is probably the most successful in the book. Written in the same style as those just described, it is distinctly more realistic and dignified in its tone. The subject-matter is also more coherent, and its treatment—for the scope of the book—exhaustive. Were all ten chapters equal to this one, we would say Prof. Cole had been most successful in carrying out a set purpose pleasantly and beneficially for cultured readers who travel at home and abroad. But unfortunately the high-water level is seldom reached in the book.

Chap. vi. dips into the lore of "Dead Volcanoes," starting with the highland of Auvergne, and returning to our own islands. Chap. vii. is a careful study of "A Granite Highland," and generally of igneous rocks. "The Annals of the Earth" (chap. viii.) gives a general account of the stratigraphical succession. Chap. ix., "The Surrey Hills," is a very happy combination of the art of seeing and describing beauty of landscape, along with the practical demonstration of the principles of stratigraphy. It resounds with the stroke of the geologist's hammer, and the enthusiasm of a true guide and teacher. Chap. x., "The Folds of the Mountains," will be to most readers difficult, as it deals with the hard subject of the making of mountain-chains. The Alps are mainly considered, the writing is admirably clear, and the doctrines taught are in accord with all the newest researches.

It remains to add how often passages occur throughout the book which remind us of the artistic feeling for nature displayed by the author in a previous publication, "The Gypsy Road." Every small detail in a scene is touched with a sympathetic, kindly pen, that reminds one of the lingering brush of a Constable. Take his description of Fenland:

"From Cambridge northward to the estuary of the Wash, there are forty-five miles of level ground. . . . Between the scattered villages lie areas of black peat, covered with coarse grass, and dug into here and there for fuel. The roads are carried along the crests of broad embankments, with dark, little drainage-cuts on either side of them, crossed by bridges to the fields. A few trees cluster round the old farm-houses, protecting them from the winds that sweep across the fenland steadily for weeks together. . . . The sky is usually full of great cumulus-clouds, dark grey below and silvery white above, where the sunlight strikes through them in long shafts across the grey-green plain. A church-tower or a windmill is visible ten miles away, when touched on by these sudden gleams; then it sinks back again into the great gloom of the horizon" (p. 121).

Taken as a whole, the book fails, in so far as it constantly mixes together two distinct styles of writing, the picturesque and the didactic. It is at the same time eminently readable, and will be warmly hailed by many lovers of geology out-of-doors. A solid groundwork is formed by the five chapters referred to above as partaking of the text-book method. The others are somewhat of a skim-swallow type, too rapid in their course, too overladen with detail and local colouring, to be adapted either to the serious wants of a student or to the slow apprehension of a complete novice in nature's fields. The book will appeal most to the dilettante student, or to the tourist who has already had abundant opportunity of observing, who delights in finding his own dim perceptions vividly mirrored by a trained scientific mind, and in seeing them marshalled towards the solution of "vexed problems of the globe."

Maria M. Ogilvie.

PRIMITIVE PICTURE-WRITING.

The Beginnings of Writing. By Walter James Hoffman, M.D. With an Introduction by Prof. Frederick Starr. Pp. xiv + 209. (London: Macmillan and Co., 1895.)

THERE is no more fascinating subject for study than the development of the art of writing through its various stages, from the first rough pictures drawn by primitive man to the alphabets in use among the civilised nations of the present day. But the historic systems of writing go back to a remote antiquity, and although we can trace some of them back many hundreds of years, the question of their first origin is one that is beset with many difficulties. It is at this point, however, that the anthropologist comes to the antiquary's help, for he shows that the mind of savage man always works along the same general lines of development. All primitive races, whether in China, Central India, Western Asia, Europe, North Africa, or North America, have used the same rude means to record their thoughts and actions, scratching on their rocks or weapons rough pictures of their possessions and pursuits. The methods used by hunters of the Palæolithic age to record a successful hunting expedition resemble those which the North American Indian now employs. From these rude pictures the savage passes, by a natural law of development, to the representation of ideas, expressing motion or condition by means of gesture-signs. Then, after certain pictures have become associated with certain words, he begins to use them to express their sound but not their meaning; in fact, he begins to write phonetically. His pictures, as he writes more rapidly, change to signs, which become more and more simplified, and finally his system of syllabic writing he develops still further till he reaches the most perfect phonetic system of writing, the alphabet.

Such in brief are the main lines of development which all races follow who work out for themselves the art of writing, and it is this attractive subject that Mr. Hoffman has selected for his book. In the brief preface in which Prof. Starr introduces him and his book to the reader, we learn that he has for some years been engaged both in field-work and study among the Indian tribes of North America, and from his book itself we find that his studies have resulted in a most interesting collection of the various methods of writing employed by these primitive races. It is true that many of his examples are already well known from other publications, but the collection does not aim at being original, for the book belongs to an educational series, where original work would be out of place. What was wanted, and what in the main Mr. Hoffman has given us, was a representative collection of the various methods of writing employed by the North American Indians. These are here classified, described clearly and illustrated with numerous small cuts; and for this part of his work we have nothing but praise. But why did not Mr. Hoffman confine his book to the subject in which he is in a sense a specialist? Why did he seek

to extend the aim of his volume so that it might apply to the beginnings of writing all the world over?

Yet such an extension Mr. Hoffman has attempted in the course of about 200 *octavo* pages printed in large type. The result was inevitable. The lion's share of the little space at his disposal falls naturally enough to the North American Indians with whose pictographs and writing he is most familiar; but, in consequence of this mistaken aim at universality, the book is peppered here and there with Egyptian hieroglyphs, once or twice a cuneiform character crops up, and we have even come across a Christian symbol. In many places, therefore, the work is patchy, and the reader is in some danger of bewilderment. Moreover, this is not the only danger to which Mr. Hoffman exposes his readers, by rashly leaving the ground he knows; for his studies have not been sufficiently extended to enable him to act as a trustworthy guide elsewhere. He is certainly wise in making considerable use of "The Alphabet," by Isaac Taylor, but some statements made twelve years ago naturally now-a-days need revision. For instance, the dates he quotes at the beginning of p. 184 must now be considerably altered in view of M. de Sarzec's recent discoveries at Telloh in Southern Babylonia. But perhaps the most misleading portions of the book are those passages in which he refers to the so-called "Hittite" inscriptions. Here Mr. Hoffman's authorities are not so trustworthy as Mr. Taylor, and the result is disastrous. From his description of these hieroglyphs, the reader would certainly infer that no doubt existed as to their interpretation, but no impression could be more erroneous. The four or five systems of interpretation that have been proposed, and the last of which appeared less than two years ago in the *Zeitschrift* of the German Oriental Society, differ totally from one another, and are mutually exclusive; that is to say, each interpreter has employed a different method and system of interpretation, and, although they all work on the same inscriptions, the translations they have produced do not agree at all. Of course Mr. Hoffman is at liberty to select one of these systems and to say it appears to him to be correct, but to take the results of one of them, and to describe them as though they were universally adopted without reference to the controversy which still rages, is surely misleading in the highest degree. Moreover, on p. 158 occurs this rather puzzling sentence: "In the Akkadian, *a* signifies 'water' . . . and is represented by the inverted triangle, the prototype in Hittite being the vase or *olla*." If we take this sentence literally, we can only infer that Mr. Hoffman considers the earliest cuneiform character to be the descendant of the Hittite hieroglyphs. We think, however, that he cannot seriously hold this view, and that the sentence referred to does not rightly express his meaning.

It is not necessary, however, to dwell at greater length on the blemishes which mar an otherwise excellent book. They might, indeed, have been avoided by the exercise of a little discretion, and the book would have been none the less interesting if its contents had been confined to the beginnings of writing among the tribes of North America. Even as it is, the greater part is both interesting and instructive, and the excellent print and numerous diagrams add considerably to its attractiveness.

OUR BOOK SHELF.

Elements of Geometry. By Prof. George C. Edwards. Pp. vii + 293. (London: Macmillan and Co., 1895.)

PROF. EDWARDS has forsaken the general sequence of parts in the study of the elements of geometry as propounded by Euclid, and has given us a book almost on a new plan. It must have been felt by most people, when in their early school-days they commenced to read Euclid's Elements, that much of the first few pages was almost unintelligible; and while no one would take exception to the rigidity of the methods there used, yet it would be exceedingly difficult for the average beginner to comprehend many of the definitions from the text alone without further *viva voce* explanation.

The substance of Euclid's Elements may be condensed into a very small fraction of its present dimensions for all practical purposes without losing any of the rigidity of argument or usefulness in application, and in this way a student may understand the proportionality of the sides of similar triangles without previously wading through four or five books. Prof. Edwards has arranged his book in this condensed form, and at the same time has presented his subject in a manner which attracts the attention of the reader by its simplicity and usefulness. One feature of this book is the great number of diagrams and figures which it contains; and where more than one figure is required with any one proposition, they are all carefully and separately given. The author does not overload the student with a mass of definitions at the commencement, but introduces them with explanations, when required, in the context. The usual mathematical conventions are introduced very early into the subject-matter, such as signs to denote directions; and the usual contractions are freely used, a table of them being given at the beginning for reference.

The first three chapters deal with propositions which relate to triangles and parallel lines; chapter iv. deals with the properties of circles; and chapter v. with areas, and the proportional relations of similar figures. This is one of the most important sections of the book, and includes some useful results which are generally obtained from books on trigonometry. Immediately following we find a chapter devoted to chords and tangents, and another to polygons and limits, including finding the value of π. Then follow over thirty pages of problem questions, with hints to some of their solutions, and innumerable figures to illustrate them where necessary. No pains appear to have been spared to make the whole as clear and intelligible as possible.

We then find a few chapters on solid geometry, which include matter dealing with surfaces, volumes, intersection of surfaces, and spherical triangles. The last chapter contains some useful propositions in conic sections.

Throughout the book there are a great number of examples, notes, suggestions and warnings to the reader, which should be of especial value to those who have not pursued the study of geometry to any extent previously. Altogether the book is a valuable one for any educational institution, and exceptionally so to technical students.

Elementary Mensuration. By F. H. Stevens, M.A. Pp. xii + 243. (London: Macmillan and Co., 1895.)

Mensuration. By the Rev. A. Dawson Clarke, M.A. Pp. vi + 88. (London: Rivington, Percival, and Co., 1895.)

MR. STEVENS' book is divided into two parts, the first only requiring a knowledge of Euclid's first book, and the use of algebraic symbols, in order to understand it; while the second part necessitates a much fuller acquaintance with geometry and algebra, and a slight knowledge of trigonometry. The book is not technical, but contains a thorough treatment of those principles upon which

all calculations of dimensions depend, and therefore it will be valuable as an introduction to works concerned with special practical applications of the rules described and exemplified. Moreover, it should play a useful part in schools, by illustrating the concrete applications of abstract geometrical principles. The large number of original examples will be found of great assistance by teachers, and the questions, selected from papers set by the principal examining bodies, will prove of service as tests of the students' capabilities in working out mensuration problems.

Of a less detailed character is the Rev. Dawson Clarke's primer, intended "for the use of schools, and Woolwich, Sandhurst, and Home Civil Service candidates." The book is a collection of rules and formulæ, with examples to explain their use, and numerous exercises selected from various examination papers. It particularly appeals to students who learn the rules of mensuration in order to utilise their knowledge in the examination-rooms of the Civil Service Commissioners; but it is, also, a concise text-book which other students will find serviceable.

Physical Measurements. By Frank C. Weedon. Pp. 232. (London: G. Gill and Sons, 1895.)

This volume is another help towards the establishment of rational methods of instruction in elementary science. It is a laboratory manual of practical physics for organised science schools under the Department of Science and Art, and other secondary schools. Of the educational value of the course contained in the book, there can be no doubt; for the experiments (which are of a character suited to beginners) follow a natural order, and are such as will develop the faculties of observation, investigation, and common sense; in fact, they will lead the student to think as well as learn. The book is divided into three sections, dealing respectively with measuring and weighing, relative densities, and experimental mechanics. Experiments on these matters elucidate the fundamental principles which form the basis of a scientific education. The knowledge cannot be labelled "Sound, Light and Heat," or "Magnetism and Electricity," and therefore superficial critics, and syllabus-bound teachers, think it is not Physics. We are of the opinion, however, that experimental work in measuring and weighing, constitutes the foundations of physics. The student who is able to weigh and measure carefully, and to observe and think accurately, knows more of the realities of physical investigation than if he had spent a dozen years in learning scraps of information about other people's contributions to knowledge.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The New Actinic Rays.

A brief account of some experiments which I have been making in my laboratory at Blythswood, in connection with the new photographic rays, may, I hope, be of interest to the readers of Nature.

Three or four years ago I constructed a very powerful Wimshurst electrical machine. It has 128 plates, three feet in diameter, and is driven by an electric motor of about 1½ horse-power. With this machine, which was specially built for quantity, I can obtain a torrent of sparks a foot and a half or two feet long: and it occurred to me to try to obtain photographs, after the manner of Röntgen, but without the intervention of a vacuum tube.

A thick sheet of lead was placed upright between the poles of the electric machine, as a screen, and was connected to the ground, the two poles being insulated. A sensitive dry plate was put into the camera dark slide, with a metallic object to be photographed (a steel washer with holes in it), and this was connected, by a wire which passed out of the dark slide, to the ground. The whole was wrapped up in four folds of a black velvet focussing cloth, and was put, in some cases between the negative pole and the lead screen, and in other cases between the positive pole and the lead screen, the plane of the slide being perpendicular to the line of discharge. In all cases good strong negatives were obtained with exposures of about twenty minutes. The machine was arranged to give a silent brush discharge during the experiments.

I next tried similar experiments with the dark slide containing the sensitive plate quite out of the line of discharge, and with the plane of the plate parallel to the line of discharge, and obtained equally good results. It seems, therefore, that the vacuum tube is not essential to the production of the Röntgen rays. With reference to this, however, I am not so sure, as I think I may have been deceived by using isochromatic plates—at all events I am engaged in further experiments either to confirm or the contrary. Blythswood.

Blythswood, Renfrew, February 10.

With reference to Mr. Porter's letter regarding the amount of electric energy and exposure required for obtaining photographs by the Röntgen method, I may mention that against his photograph taken with a 3-inch coil and four minutes' exposure, I can instance a successful human foot that shows the bones very distinctly almost up to the ankle-joint, in taking which I used a 10-inch coil working at about half power without Leyden jars, and for which fifty-five seconds' exposure proved ample.

For living physiological subjects, it is very important to shorten the exposure as much as possible, and to attain a minimum in this respect, very high vacua and considerable E.M.F. are requisite.

Again, for an extensive subject, a large tube placed at a considerable distance from the subject is required, and more electric energy is needed for this than for a small subject, for which a smaller tube in closer proximity will suffice.

66 Victoria Street, S.W. A. A. C. Swinton.

Having made some experiments on the lines laid down by Mr. Gifford, of Chard, I think the two enclosed photographs will prove of interest, as showing perhaps that Mr. Gifford's method of dispensing with a Crookes' tube introduces elements of another character. Both these negatives were taken without a tube, using the discharge from the terminal of a small Tesla transformer. In each case a metal plate was placed behind the film in communication with the other terminal of the coil. Under these conditions a stream of "discharge" passes from one terminal through the photographic film.

The interesting point is that not only does the outline of the coin come out, but also the impression. And that in the case of the florin the coin was placed *behind* the film. The same sparking appearance as described by Mr. Gifford is evident.

From the fact that it is immaterial on which side of the photographic film the coin is placed, it is evident, I think, that we have here to do with a "contact" phenomenon, and not with Röntgen's rays at all. Sydney D. Rowland.

38 Wimpole Street, W., February 2.

"The Astronomical Theory of the Glacial Period."

As it was my two letters which initiated the interesting and not unfruitful discussion now going on in your pages on the above subject, I think it right to say a few words in reply.

The object of my letters was to point out (perhaps I did it in somewhat too heated language) that Sir Robert Ball, whose personal and official distinction give his words exceptional weight, had in his work entitled "The Cause of an Ice Age" given fresh currency to a discredited theory, and further that when this had been pointed out, he had refused to take any notice of his critics, and continued to publish his book.

In his letter to you, Sir R. Ball (if I do not misunderstand him) entirely breaks away from the position maintained in his book, and gives up the case there argued, definitely and completely. While Prof. Darwin, who had given the book the advantage of his friendly recommendation and countenance, tells us he is now reluctantly compelled to take the other side.

So far as I know, there does not now remain a single mathematician or astronomer who favours a purely astronomical theory of an Ice Age; a theory which, as Arago, Humboldt and Croll, all urged long ago, is quite inadequate to explain the climatic effects required. Every one, as far as I know, now agrees with the American astronomer Meech, who subjected the astronomical theory to a most searching analysis, as far back as 1857, that "the causes of notable geological changes must be other than the relative position of the sun and earth under their present laws of motion." It is with this sentence that I close my own analysis of the problem in chapter ix. of my "Glacial Nightmare."

As I understand, Sir R. Ball in surrendering his old view, which was *that astronomical causes by themselves* are sufficient to produce an Ice Age, falls back upon a modification of Croll's meteorological argument. While, however, he no longer relies on the adequacy of astronomical causes alone as competent to produce an Ice Age, he does not admit the conclusiveness of Mr. Culverwell's argument, but bids us remember that the world cannot be cut up into a number of parallel zones shut off from each other by solid partitions, each one of which can be treated as a separate climatic region, but that the climate of every zone is very largely indeed the result of heat brought in or carried away by air and water from or to other zones. No one disputes this. It is in fact an elementary postulate of meteorology, and applies as much to Sir R. Ball's arbitrary zone termed a hemisphere as to any other.

What we want Sir R. Ball to do is not to rest content with this barren postulate, but to apply it as Croll applied his postulates, and to prove that, granting the greatest possible alteration of the relative length of the seasons due to eccentricity, &c., which, as Mr. Culverwell has shown, will by itself tend to shift the climate of each zone about five degrees, how is this going to affect the circulation of the air and of ocean currents sufficiently to constitute an Ice Age? This was the problem Croll virtually set himself to analyse by a minute and ingenious investigation.

Croll's arguments have been riddled through and through by several writers, and in this behalf I may perhaps venture to again refer to a minute dissection of them in a chapter, headed "Transcendental Meteorology," in the work already cited, namely, the "Glacial Nightmare," and which I have been told by some eminent physicists is unanswerable. I can, at all events, say it has not been answered.

If Dr. Ball can discover some method of curing the radical defects of Croll's arguments, he will have made us a valuable present. Meanwhile, if I do not entirely misunderstand his present position, it is more clear than ever that he owes it to us all to withdraw his "Cause of an Ice Age" from circulation, for it has not only been condemned by its distinguished and formerly friendly critic, but has been actually condemned by its own author. HENRY H. HOWORTH.

Athenæum Club, January 30.

The Positions of Retinal Images.

PROF. KULPE, in his "Outlines of Psychology" (translation by Prof. Titchener), sets out with much effectiveness the argument in favour of believing that the visual perception of extended surface is an original datum of consciousness attached to the extended retinal surface (and no more to be explained than why the sensation red feels the way it does, and not otherwise); and he also shows conclusively that the peculiarity of nerve-excitation by which right- and left-ness and up- and down-ness are distinguished, is of peripheral (and not of central) origin; by adducing the facts of metamorphopsia, that is, the cases in which a portion of the retina has become detached by a wound, and has afterwards grown on again, and in which vision is correspondingly inverted—exactly as when a piece of the skin of the forehead has been grafted upon the nose, say, and upon touching it we seem, for a long time afterwards, to be touching the forehead. He thus attaches himself to the innate-space-sensation theory of James and Sumpf. But his effort to show that the out- and in-sensation is fundamentally dependent upon the different shape of the image cast upon the two retinas by an object, carries less conviction with it. This is, of course, an essential element of the sensation when the object looked at is so complex as to consist of two points at a given distance from each other. But when it consists of a single bright point only, we are still perfectly able to determine its position in depth (if it is looked at with two eyes), and the sensation-element which enables us to do this is plainly more *fundamental* than the other. To say the least, it is something which ought not to be overlooked.

It is plain that in this case the only criterion which is left us (granting, what is the case, that the localisation can be effected with certainty with two eyes, but only vaguely and indefinitely with one) is *the distance apart of the double images*; it is that which we estimate, unconsciously of course, in spite of the fact that one image is in one eye and the other in the other, and it is that which we translate, without difficulty, into a feeling of depth. But there is always an ambiguity; for every point, O (Fig. 1), without the horopter-circle, which casts images upon the retina at the points r and l, there is a congruent point, O′, within the horopter-circle, which casts images upon the corresponding retinal points, l' and r', and which, therefore, gives images which are at the same distance apart. We have no difficulty in sensation in distinguishing between a bright point at O and one at O′, but how can this be effected? There is still a difference in sensation between the two cases. The nasal half of each retina gives distinctly brighter images than the temporal half; in the case of the object O, which gives the two images, r and l, the remoter one is the brighter, while in the case of the object O′, which gives the images l' and r', it is the nearer one which is the brighter. A bright image of the object, which seems to us to be the thing itself, is attended by a somewhat fainter secondary self, whose presence we are absolutely unconscious of, in our non-scientific lives, as an image,[1] but which we evaluate with the utmost nicety as a sign of the distance away of the real object,

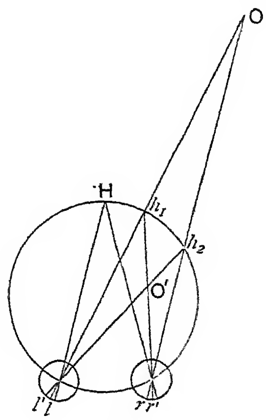


FIG. 1.

and which has, moreover, a different significance according as it stands nearer to, or further from, the fixation point than the image which we regard as the object itself. This explanation may seem at first to vary much in the air, but its correctness has been demonstrated by Schön in a very ingenious manner (*Arch. f. Ophthalm.*, xxii. and xxiv.). His experiment has been unaccountably overlooked by all the makers of text-books, as far as I have seen, but it is of critical importance. He arranges a series of screens with openings in them in such a way that *two different* bright objects are seen, one by the right eye only, in the line h_2 O produced, and the other by the left eye only, the line h_1 O produced. The *positions* of the double images now correspond equally well for an object at O or at O′; and the person experimented upon thinks he sees an object now at O and now at O′, exactly in accordance with the way in which the relative brightness of the objects beyond the screens is made to vary. When the image which falls at r is brighter than that which falls at l, the object is seen at O; when the image which falls at l is brighter than that which falls at r (sufficiently brighter, of course, to counteract the relative efficiency of the different halves of the retina) the object is seen at O′. It is therefore demonstrated that it is the relative brightness of the images which is the determining factor in enabling us to localise objects in one or other of the two congruent worlds without and within the horopter-circle. I have myself repeated the experiment with perfect success. C. LADD FRANKLIN.

Baltimore, January 13.

[1] There are many people who cannot bring the secondary image into consciousness, no matter how hard they try, when it falls at any distance from the fovea.

Brazilian station, and it affords me very great pleasure to bring this before you, because it enables me in this public way, as President of the Vesey Club, to tender thanks to Sir Benjamin Stone for the help he gave the Brazilian party.

We next pass to the results which were obtained by Messrs. Fowler and Shackleton, who were in charge of the instruments at the two stations. The diagrams will indicate the kind of celestial hieroglyph—to come back to the old image—we have to deal with when this method is employed.

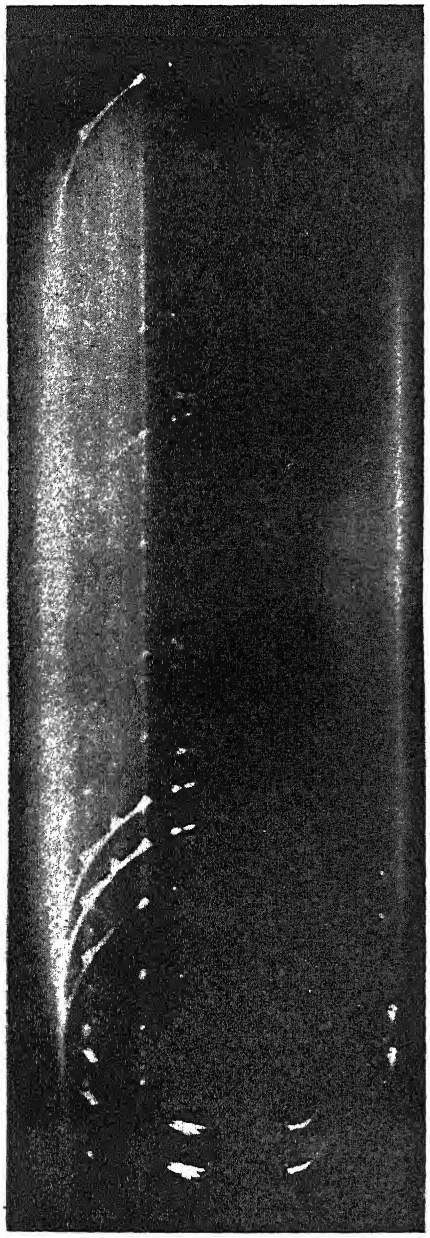


FIG. 11.—Untouched reproduction of photograph (African station) taken very shortly after the commencement of totality, the exposure being "instantaneous." At this phase of the eclipse a considerable arc of the chromosphere was visible, and its spectrum is therefore shown in addition to the spectrum of the higher reaches of some of the large prominences extending beyond the moon's limb. It will be seen that at H and K there are long arcs of chromosphere and prominences, the absent portions being of course obscured by the moon. One very small prominence is especially rich in lines.

We get more or less complete rings when we are dealing with an extended arc of the chromosphere, or lines of dots when any small part of it is being subjected to a disturbance which increases the temperature and, possibly, the numbers of the different vapours present.

The efficiency of this method of work with the dispersion employed, turns out to be very marvellous, and in securing such valuable and permanent records as these, you will acknowledge that we have done very much better than if we had contented ourselves with the style of observations that I have referred to as having been made in 1871.

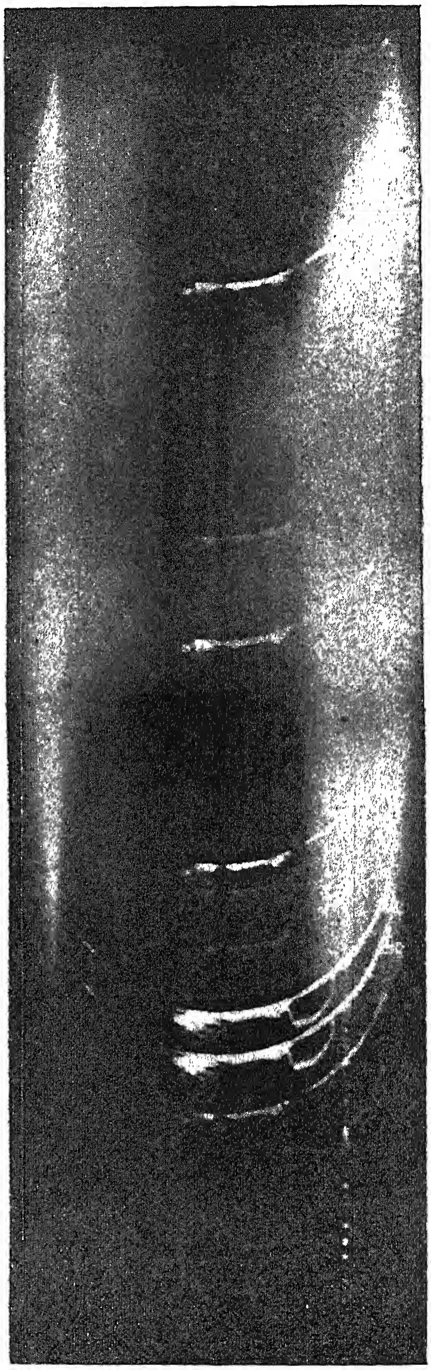


FIG. 12.—Photograph 21 (African station), taken shortly before the end of totality. A portion of the chromosphere on the other edge of the dark moon is now visible in addition to numerous prominences. It will be seen that one of the smallest prominences is rich in lines, and closely resembles that which appears in Fig. 11.

And now the plot of my story begins to thicken. On examining these eclipse records, we find that we have to do exactly with those unknown lines which had already been photographed in the stars and in the nebulæ.

As was to be expected we, of course, deal with the lines recorded in the first observations of the solar dis-

turbances, and chronicled in that table of Prof. Young's, to which I have already called attention; but the important thing, the unexpected thing, is the marvellously close connection between eclipse- and star-spectrum photographs.

CHAPTER V.

Again I recall you from the heavens to the earth; the time is the beginning of the present year.

You remember that last year was made memorable by the announcement of the discovery by Lord Rayleigh and Prof. Ramsay of a new gas called argon, and you know that the discovery was brought about chiefly in the first instance by the very accurate observations of Lord Rayleigh, who found that when he was determining the weight of air in a globe of a certain capacity, the weight depended upon the source from which he got the nitrogen.

From the nitrogen from atmospheric air he obtained one weight, and from that obtained by certain chemical processes he obtained another, and ultimately it was found that there was an unknown element which produced these results, these various changes in the weight; and as a consequence we had the discovery of argon.

It struck Mr. Miers, of the British Museum, that it might be desirable to draw attention to the nitrogen which we have seen Dr. Hillebrand in 1888 obtaining from his crystal of uraninite; his observations, of course, were more in the mind of Mr. Miers than in the minds of the pure chemists. He therefore communicated with Prof. Ramsay, who lost no time, because it was very interesting to study every possible source of nitrogen and see what its behaviour was in regard to the quantity of argon that it produced, and in the relation generally of the gas to the argon which was produced from it.

Prof. Ramsay treated uraninite in exactly the same way that Dr. Hillebrand had done in 1888. The gas obtained as Dr. Hillebrand had obtained it was eventually submitted to a spectroscopic test, following Dr. Hillebrand's example. But here a noteworthy thing comes in. *It so happened* that the pressure and electrical conditions employed by Prof. Ramsay were so different from those used by Dr. Hillebrand that, although nitrogen was undoubtedly present, the fluted spectrum which, as I have previously stated, floods the yellow part of the spectrum with luminous details, was absent. But still there was *something* there.

Judge of Prof. Ramsay's surprise when he found that he got a bright yellow line; that was the chief thing, and *not* the strong suggestion of the spectrum of nitrogen. Careful measurements indicated that the twenty-six-year-old helium had at last been run to earth, D^3 was at last visible in a laboratory. Prof. Ramsay was good enough to send specimens of the tubes containing this gas round to other people, and he sent one of them to me.

I received Prof. Ramsay's tube on March 28, but as it was not suitable for the experiments I wished to make, in his absence I obtained some gas for myself by a different method with which I need not trouble you. From March 30 onwards my assistants and myself had a very exciting time. One by one the unknown lines I had observed in the sun in 1868 were found to belong to the gas I was distilling from bröggerite, not only D^3 but 4923, 5017, 4471 (Lorenzoni's *f*) 6677 (the BC of Fig. 7), referred to previously, and many other solar lines, were all caught in a few weeks.

But this was by no means all. The solar observations had been made by eye, and referred therefore to the less refrangible part of the spectrum, but I had obtained and studied hundreds of stellar photographs, so I at once proceeded to photograph the gas and compare its more refrangible lines with stellar lines.

Here, if possible, the result was still more marvellous. In the few-lined stars, by May 6, I had caught nearly all the most important lines at the first casts of the spectroscopic net. Fig. 13, which includes some later results, will give an idea of the tremendous revelation which had been made as to the chemistry of some of the stages of star-life.

These results enabled us at once to understand how it

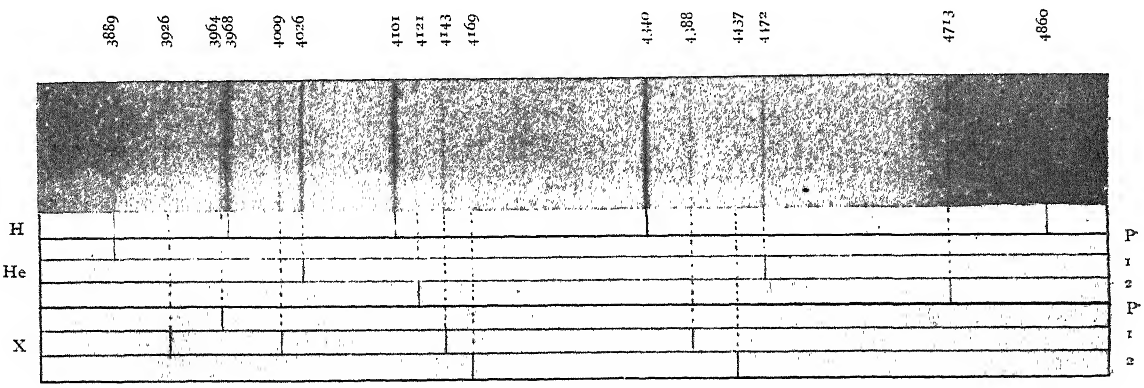


FIG. 13.—The spectrum of Bellatrix showing the lines of hydrogen and those which have been traced to the gas obtained from minerals.

was that the "unknown lines" had been seen both in the sun's chromosphere and some nebulæ and stars. The gas obtained from the minerals made its appearance in the various heavenly bodies in which the conditions of the highest temperatures were present, and the more the work goes on we find that this gas is really the origin of most, but certainly not of *all*, of the unknown lines which have been teasing astronomical workers for the last quarter of a century.

A great deal of work has been done upon these gases from other points of view than those which affect my story, and perhaps I may be allowed just to refer for a minute or two to one of the results which have been obtained by myself.

It is perfectly obvious that the gas as obtained from uraninite is a mixture of several gases; that the gas which gives the yellow line has not yet been isolated, but is always mixed up with other gases which give other lines.

In May I communicated to the Royal Society some experiments which indicated in a most conclusive manner the fact that the lines D^3 and 667, to deal with two only for the sake of simplicity, were not produced by the same gas, and that 667 seemed to be a compound gas of which D^3 represents one of the constituents.

Some little time after, Profs. Runge and Paschen, from

an entirely different standpoint, arrived at exactly the same conclusion. They recognised two gases, one represented by D^3, the other by 667, and further they showed that the lines might be arranged into six similar and beautifully rhythmic series, a principal and first and second series for each gas. These are indicated in the diagram of Bellatrix on p. 345, and in Fig. 14; He = helium is the gas which contains D^3, the other gas I so far call "gas X."[1]

This result is, however, more important from the chemical than from the astronomical point of view *at present*.

A word in conclusion referring to the occurrence of this gas in terrestrial minerals.

We are brought face to face with one question, which ought to influence many lines of work for many years to come. I have already suggested to you that we really now can talk with something like certainty and definiteness about hot stars and cooler stars, and that in the hottest stars we know of, the atmospheres of those stars consist almost entirely of hydrogen and helium.

But see what a little trace of helium we have in this small planet of ours, which undoubtedly was once a sun, which undoubtedly once had an atmosphere just as glorious in its hydrogen and its helium as any of the other stars are now glorious.

What has become of that helium? This question will have to be very carefully considered in the next few years.

We appear to be in presence of the *vera causa*, not of two or three, but of many of the lines which so far have been classed as "unknown" by students both of solar and stellar chemistry, and we are also apparently in the presence of a new order of gases of the highest importance to celestial chemistry, though perhaps they may be of small practical value to chemists, because their compounds and associated elements are for the most part hidden deep in the earth's interior. Why do I suggest a *new* order of gases? Look at the facts.

All the old terrestrial gases, with the exception of hydrogen, are spectroscopically invisible in the sun and stars—though they doubtless exist there—and these new gases, scarcely yet glimpsed, have already supplied us with many points of contact between our own planet and the hottest part of our central luminary that we can get at, and stars like Bellatrix.

The work certainly is full of hope for the future, not only in relation to the possibility of more closely correlating celestial and terrestrial phenomena, but since it indicates that terrestrial chemistry, founded on low density surface products in which non-solar gases largely enter, is capable of almost infinite expansion when the actions and reactions of the new order of gases, almost, it may be said, of paramount importance in certain stages of stellar evolution, shall have been completely studied.

I have some other results to refer to, but it is quite sufficient, I think, to leave my story as I have told it to you without going back on any of the characters, or without dealing in any greater detail with the *dénouement* of the plot.

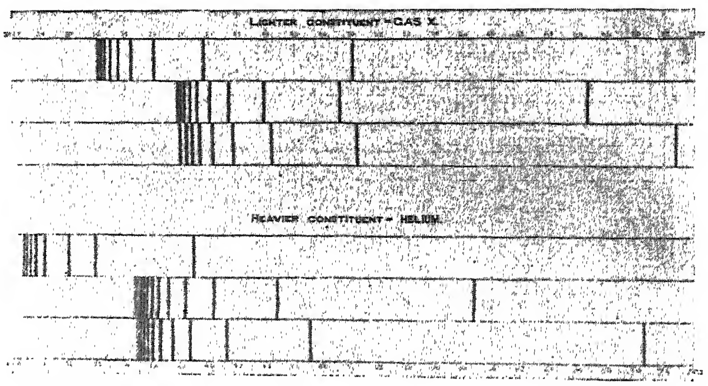


FIG. 14.—Runge and Paschen's results suggesting that cleveite gives off two gases, each with three series of lines.

[1] In the many comparisons I had to make, I soon found the inconvenience of not having a name for the gas which gave 667, 501, and other lines. When, therefore, Profs. Runge and Paschen, who had endorsed my results, and had extended them, called upon me, I thought it right to suggest to them that, sinking the priority of my own results, we should all three combine in suggesting a name. Prof. Runge (under date October 20) wrote me, "the inference that there are two gases is a spectroscopical one, being based on the investigation of the 'series.' Now, though we think this basis quite sound, we must own that the conclusion rests on induction. . . . For this reason we do not want to give a name to 'gas X.'" I have so far suggested no name, though Orionium and Asterium have been in my mind.

But the story has a moral. The more we can study the different branches of science in their relation to each other, the better for the progress of all the sciences. Another point is, that in the study of nature we behave in a very foolish way if we think there is anything unimportant which comes under our eyes. *If it had so happened* that Dr. Hillebrand had seen the line spectrum of nitrogen in 1888, we should have saved all these seven years of waiting for this terrestrial source of helium; and I may add, further, that argon would have been discovered as well in the first hour's work. In science, results of the first importance depend upon the minute examination of so-called residual phenomena; it is too much the general tendency, of scientific work on a large scale, to think too much of those results which may have a practical importance.

Geologists, natural philosophers generally, have been familiar with the mineral world for a considerable number of years. What have they been doing all the time? They have confined their attention too exclusively to the contained metals, and have neglected the gases; whereas it now seems that if they had been less careful of the metals, and had studied the gases, it would have been very much better for our nineteenth century knowledge. And that is the moral of my simple story.

J. NORMAN LOCKYER.

SCIENCE TEACHING IN SECONDARY SCHOOLS.

THE School Syllabus of Chemistry and Physics, which has just been put forward by a Committee of the Incorporated Association of Headmasters, is an attempt to indicate to those who are dissatisfied with the ordinary course of qualitative analysis, the lines on which the practical study of science may be made more profitable.

It is a great misfortune that in constructing a syllabus for use in schools, one has constantly to keep in mind its relation to the examination fiend. A short notice upon this syllabus, in this journal on Jan. 16 (p. 262), contained the observation that the teaching in schools is governed entirely by the examinations; and nothing could be more sadly true, nor a greater hindrance to a more rational system of teaching.

A syllabus may be perfect of its kind, but school authorities do not ask "How will it develop certain powers?" but "How will it examine?" and they base their estimation of it upon the answer to this question; while the relative value of the two in the eyes of parents

may be judged from the fact that many a parent who grumbles at having to pay £6, £7, or £8 a year for his son's education, willingly pays a 30*s.* or 40*s.* fee for the examination which tests it. As a matter of fact, if £7 be a fair sum to pay annually for a boy's education, an examination at the same rate would be rather overpaid with half-a-crown.

Our whole system of examinations rests upon a wrong basis; it assumes that the value of a boy's education depends upon how much he has learnt, whereas the true criterion is how he has learnt it. The climax of absurdity is reached in those examinations which test the knowledge of a language, as French or German, by the knowledge a pupil has of one specified book; it is true that some of our examining bodies have attempted to meet this difficulty by setting books of an extremely uninteresting character, in order that the pupil's attention, not being able to find interest in the subject-matter, may be solely occupied with the language, but that is a digression.

Those who have taught science in schools have long been dissatisfied with the ordinary course, and have felt the necessity of a change; but the question, "What change?" has hitherto been asked in vain. In answering this question, it is important to bear in mind that we do not want to train boys to be chemists or physicists; that is the part of the technical institute, and a system of instruction which may be excellent for producing trained chemists may be extremely unsuitable for developing the latent powers of children.

The chief principles which it is hoped to introduce by means of this syllabus are as follows.

The insistance at the outset of *measurement* as the chief factor in scientific work, and as the basis of reasoning. It is not too much to say that all scientific reasoning is the outcome of measurement, but measurement has been conspicuously absent hitherto from our school courses, and the balance, which is often stated to be the instrument of precision of chemistry, has never yet had its due place in the chemical teaching. The mental realisation of the value of numbers, and what a theologian would call an "experimental faith" in arithmetic, are important results from this kind of work. The figures in an arithmetic book, however they may profess to deal with concrete substances, represent to a boy's mind only abstract ideas, which, by means of skilful juggling, may be made to produce certain "answers," but the answers convey to him no meaning. A good instance of this is found in his view of decimals; any average boy will tell you that a mistake in the first or second decimal place causes his sum to be wrong, but the misplacement of a decimal point is not worth considering; in practice the former error is a trifle, the latter causes a grotesque absurdity.

Another point of value in the syllabus is that it teaches a boy to perform experiments with a definite purpose, and to suggest experiments himself—to put, in fact, questions to nature. Herein lies its great superiority to qualitative analysis, which, as practised in most schools, is scarcely superior to the setting of puzzles. Any boy who has worked intelligently through this course can scarcely fail to have a much better idea of the problems which natural science has to attack, and of the reasoning which is brought to bear upon them, than one who has obtained a greater amount of knowledge from text-books and lectures.

A valuable lesson which may be learnt from this syllabus is that of writing down in good English prose a systematic account of any experiment done, and of the conclusions to be drawn from it. The lesson, in fact, becomes largely a literary one. The faculty of doing this is extremely rare amongst boys leaving school, because it has hitherto never been cultivated, and the ordinary courses of analysis, whether quantitative or qualitative, rather discourage it than otherwise. Professors who continue our boys' education in higher colleges complain, with reason, of its absence, and, once acquired, it cannot fail to be of great advantage in every walk of life.

A great advantage to which I, as a schoolmaster, can bear witness, is the influence of this teaching upon the other work of the school; it has caused masters who teach other subjects to appreciate the value of teaching practically, and of reducing text-books to a secondary place. No consummation could be more devoutly to be wished especially in view of the present colossal output of worthless text-books, which boil down every difficulty and compress all knowledge into a few pages; and the general value of which is well instanced by the advertisement of a French grammar now before me, which states that several school masters and mistresses have given very successful lessons out of this book, *without any previous knowledge of the language.*

I have omitted some of the more obvious advantages of this syllabus, the importance of a definite connection between lectures and laboratory work, the training in manipulation, and the development of step-by-step reasoning, and I pass on to consider some of the objections which have been urged against this syllabus.

Although there have not been wanting objectors to the syllabus, especially the chemistry part of it, I have found it difficult to induce them to formulate objections definitely; and when they have done so, many of the objections raised appear to me to be positive advantages. Amongst these I class the following statements.

That it requires closer attention and more work on the part of the teacher, that it necessitates small classes, that it is unsuitable for examination.

The only objections I have ever heard which appear to me to require answering are the three following:

(1) That many of the experiments are unsuitable for boys; one experiment which has been specially mentioned in this connection, and which, I own, startled me before I tried it, is the production on burning hydrogen of sufficient water to estimate its physical constants. The best answer to this is, "Try it." If a boy can be taught to burn a jet of hydrogen at all, nothing is easier than that he should burn it under a retort kept cool by a stream of water running in at the tubulure and out at the neck; and if eight or ten couples are doing this, it is surprising what a large amount of water can be collected in half an hour. A little experience will enable any teacher to simplify the experiments to the capacity of his class.

(2) That the results of experiments are often so far from accurate as to be worthless. This objection proceeds from an insufficient appreciation of the aims of the work. It is true that a schoolboy will not obtain Stas's numbers, but he will obtain numbers which show a remarkable concordance when the average of all the experiments done by various members of the class are taken, and which will enforce upon his mind the law of definite proportions.

A boy may find that H and O combine in the proportion of 1 : 7·3, that chalk contains 42·8 per cent. of CO_2, or that phosphorus and oxygen combine in the proportion of 100 : 113; but when eight or ten couples have obtained similar figures, the lessons of the definiteness of the reaction, and the importance of careful quantitative work, may be learnt as thoroughly as from more accurate results.

(3) Is it not a waste of time for a boy to laboriously work out a fictitious discovery when he could learn it in five minutes by being told it, or by reading a book? *Yes*, if committing facts to memory be the desired end; but *No*, if the end be to form habits of inquiry and of thought, to understand scientific reasoning, and to prepare the mind for dealing with problems where the text-book is not available.

If I may be allowed to speak of my own experience as a teacher, I have now taught on these principles for some time, and I can positively say that I believe this system

to be infinitely superior to the ordinary method of lecturing on the non-metallic elements and on physics, and setting qualitative analyses as practical work. The only examination of which I had experience lately is the London University Matriculation, which has recently introduced practical questions; my boys have always gone up with confidence, and found these distinctly easy, a matter in which others with whom they compared notes have not agreed with them. I have never had a failure in chemistry.

At the same time, I must insist upon the point that I do not believe that this kind of knowledge can be properly tested by examination; the true criterion of the success of this syllabus must be the opinion of those professors who carry on the scientific education of our boys after they have left us. I have received a large number of letters from various professors, in which they complain bitterly of the present preparation of most of their students, and state that they believe such changes as those contemplated by this syllabus would be of the greatest value. One of these I feel justified in quoting.

"I am a very strong advocate for change in the method of teaching science in schools. The method that usually prevails is, in my opinion, worse than barren. Not only is no satisfactory foundation laid for future teaching, but bad and slovenly habits of mind and manipulation are formed, with the result that a large portion of my work and that of my colleagues consists in the attempt (too often futile) to eradicate these habits."

The syllabus, if it has a fault, is that it is too long for an elementary course. Several of the Committee were of opinion that a course on mechanics, to lead up to the construction and use of a balance, would be sufficient; but it was pointed out that the Science and Art Department would not accept any syllabus which did not include a complete course of statics. This will explain why the syllabus includes an amount of statics out of all proportion to the other subjects; it is a sacrifice to the examination fiend; personally I should leave this work for a more advanced course.

I can, in conclusion, heartily recommend to all science teachers to try this syllabus with their classes of beginners, not following it slavishly, but adopting those points which appeal to their experience.

CHARLES M. STUART.

NOTES.

LORD KELVIN reaches this year his jubilee as Professor of Natural Philosophy in the University of Glasgow. The event will be recognised by a joint celebration, in which the City, University, and students will take part, on June 15 and 16. It is anticipated that delegates and addresses will be sent from numerous home and foreign Universities to express the esteem in which the distinguished investigator is held.

THE date fixed for the next "meeting for discussion" at the Royal Society is April 23, when the subject will be "Colour Photography," and the discussion will be opened by Prof. Lippmann.

THE Bakerian Lecture will be delivered before the Royal Society on the 20th inst., the lecturer for the year being Prof. Roberts-Austen, and the subject, "The Diffusion of Metals." The Croonian Lecture will be given, probably on March 12, by Dr. A. D. Waller, who has chosen for his subject, "Electrical Changes in Isolated Nerve."

THE Odessa correspondent of the *Times* says that the Russian Government will send a special scientific expedition to observe the total eclipse of the sun on August 9. The expedition will be in charge of three astronomers from the Nikolas Observatory at Pulkova, and leaves Odessa in May, by one of the cruisers belonging to the Russian Volunteer Fleet Committee, for Vladivostok, whence it will go near the mouth of the river Amour for observations. The Committee has agreed with the Government to convey the party from Odessa to Vladivostok and back again to Odessa free of charge.

A COMMITTEE was formed in Paris, in December last, to obtain the means for erecting a monument to Pasteur, by international subscriptions. In the furtherance of this resolution a circular has been widely distributed, appealing for funds, and asking for the organisation of local committees, so that the monument in Paris shall be worthy of the man whose labours against disease and death it will commemorate. The French Comité de Patronage includes the President of the Republic, many of the Ministry, and a large number of distinguished scientific men; while the Commission which is organising the memorial is composed of members of the Council of the Pasteur Institute. It is to be hoped that a generous response will be made to the committee's appeal for subscriptions and assistance.

A CIRCULAR has recently been issued to draw the attention of biological professors and lecturers to a course of instruction in Marine Biology which has been organised in connection with the Plymouth Laboratory of the Marine Biological Association. This course, which is intended to be supplementary to the ordinary academical courses in Comparative Anatomy, will be conducted during the forthcoming Easter vacation between March 23 and April 24, and will be superintended by Mr. W. Garstang, Fellow and Lecturer of Lincoln College, Oxford, and formerly naturalist on the staff of the Plymouth Laboratory. England has undoubtedly been behind the times in the lack of any organised arrangements by which biological students could be enabled to enjoy the various advantages which a well-equipped marine laboratory affords for the study of some of the more fascinating aspects of animal life; and it is to be hoped that this new departure in biological education in England will meet with the success and encouragement which it deserves.

JUDGING from a Reuter's telegram, a meteorite which fell at Madrid on Monday produced exceptionally striking effects. Reports of remarkable meteoritic falls are comparatively rare, so we give a fairly full transcription of the telegram:—"At half-past nine this morning an aerolite of considerable size exploded in the atmosphere above Madrid. The phenomenon was accompanied by a vivid glare of blinding light, followed by a loud report, which caused a general panic among the people. All the buildings in the city were shaken, and many windows were smashed by the concussion. The sky was clear and the sun was shining brightly at the time of the explosion, all that was visible in the heavens being a white cloud bordered with red, which was travelling eastward at a great rate, leaving behind it a train of fine, light dust. The panic was general throughout the city. Many shopkeepers closed their establishments. Not only were buildings shaken, but at least one house is known to have collapsed. At the United States Legation a partition wall fell in, and many of the windows were shattered, but no other damage was done to the building. A great many houses throughout the city sustained similar damage, partition walls being shaken down by the force of the explosion. The excitement in the city, and especially in the suburbs, has not yet calmed down. The explosion was heard over a distance of several kilometres from Madrid. At Guadalajara, a town about forty-six miles from the capital, the explosion was very strongly felt." The following official communication has been issued from the Madrid Observatory:—"At 9.29 this morning a strong light was observed proceeding from a small cloud moving from the south-west to the north-east. A minute and a half later a terrific report, followed by several others of less intensity,

occurred, accompanied by a shaking of the ground and of buildings. A red-tinted cloud was for a long time visible in the east. The directors of the Observatory suppose that the phenomenon was caused by an aerolite. Owing to the time that elapsed between the observation of the explosion and the report, the aerolite must have burst at a great distance from the earth." The note adds that no traces of the meteorite have yet been found. Nevertheless, it is reported that several small pieces of greyish stone, still warm, have been picked up in Madrid.

GREAT interest has been aroused in France by the discoveries of Prof. Röntgen, and experiments have been at once made confirming and extending the original results. Last week's number of the *Comptes rendus* contained further work by M. Jean Perrin on the properties of the kathode rays (see *ante*, p. 298), showing that they are not identical with the Röntgen rays. The current issue (February 3) contains papers on this subject by MM. L. Benoist and D. Hurmuzescu, A. Nodon, V. Chabaud, and G. Moreau. The first of these gives an account of a most remarkable property of the rays, that of completely and rapidly discharging an insulated charged electroscope, the effect being produced more rapidly if the charge borne by the gold leaves is a negative one. This phenomenon is not in any way interfered with by an aluminium screen, although the latter protects the electroscope perfectly from both light and electricity. The note by M. Nodon further emphasises the difference between these rays and the ultra-violet rays. An ordinary dry plate wrapped in several thicknesses of blackened paper was exposed at a distance of 40 c.m. from a powerful arc lamp (20 amperes) for fifteen minutes; on developing, the plate was unaffected, although under the same conditions the Röntgen rays produced a very marked result. The latter also were found to pass with equal facility through differently coloured screens of the same material. The transparency of metals to the X-rays is the subject of the communication by M. Chabaud. Fourteen metals and alloys were examined by the photographic method, the results being substantially identical with those published by Prof. Röntgen in his original paper; results which were obtained very simply by the use of a phosphorescent screen. M. Chabaud makes no reference to these earlier experiments on the same subject. The two metals most opaque to these rays are those of the highest atomic weights, platinum and mercury, the most transparent being that with the lowest atomic weight, aluminium. M. Moreau dispenses with the Crookes' tube altogether, and uses the brush discharge of an induction coil; the curious result being obtained, that if the box containing the plate be placed normally to the brush, there is no effect, whilst placed parallel to the brush, strong, clear negatives are produced. No explanation of these experiments is attempted.

THE same number of the *Comptes rendus* also contains a second note by M. G. Le Bon, on photography with "dark light." By placing a sensitive plate under a negative, covered with a metallic plate 0·5 mm. in thickness, and exposing to the light of a lamp, good images are obtained on development, especially if a piece of lead is bent back over the frame, so that the whole printing frame is in a sort of metallic box. M. G. H. Niewenglowski mentions that these results can be obtained without any lamp at all, and hence suggests that they must be due to luminous energy stored up in the negative. But further experiments by M. Le Bon have completely eliminated this source of error, as the same results are obtained with negatives which have been previously submitted to blank experiments in the dark. From the point of view of Maxwell's theory of light, rays which can pass through 0·5 mm. of copper must differ essentially from ordinary light, and M. Le Bon proposes to next examine within what limits these dark rays submit to the laws of refraction, and how far they are affected by a magnetic field.

IT is announced that Dr. Kitasato, of Japan, has succeeded in inoculating for leprosy, and that the disease is curable.

THE formal presentation of the portrait of Mr. W. Carruthers, F.R.S., to the Linnean Society, was made at its meeting on February 6, by Sir W. H. Flower, on behalf of the subscribers.

THE Annual Congress of the French Association for the Advancement of Science will be held this year at Tunis, between the 1st and 11th of April. The Botanical Society of France will also hold its Extraordinary Session at the same place, and about the same time.

A COURSE of six lectures to working men, on "Fermentation," by Dr. W. P. Wynne, will be given in the Lecture Theatre of the Museum of Practical Geology, Jermyn Street, commencing on Monday, February 24.

A CONGRESS of Natural History and Scientific Societies of the South-East of England will be held at Tunbridge Wells on Saturday, April 25, under the presidency of the Rev. T. R. R. Stebbing.

THE practical extinction of the buffalo, or American bison, is very forcibly shown by an article recently published, which states that 300 dols. is now refused for a good buffalo robe, such as could at one time early in the seventies have been bought for a dollar, or even less.

WE are requested to state that the arrangements are now complete for lighting in the evening the Southern Galleries of the South Kensington Museum on the west side of Exhibition Road, which contain the collections of machinery and naval models. These Galleries will be open free to the public from February 17 on three evenings a week—Mondays, Tuesdays, and Saturdays, till 10 p.m.—in the same manner as the main building.

ANOTHER of the wonderful potentialities of the Niagara water-power is its application to the new process of Blumenberg for the manufacture of chlorate of potash by the action of the direct electric current upon tanks of potassium chloride. The electric current is at a remarkably low voltage. Important by-products are also obtained. Operations will begin next July. The Alkali Union, which controls the world's output of chlorate of potash, has reduced the price from 17 to 10 cents a pound, in anticipation of this undertaking; but the new manufacturers will probably undersell them in all the markets of the world.

THE new illuminant, acetylene, seems to be notable for its efficiency and the cheapness of its production by the electrical manufacture of calcic carbide, from which it is evolved by the mere application of water. Calcic carbide is already made at Spray, North Carolina, at a cost of 20 dols. per ton, by the alternating electric current passed through a mixture of powdered coke and lime. Works have been erected at Niagara which will produce the calcic carbide at 10 dols. a ton, beginning about the middle of this month. One ton of the carbide yields 11,000 cubic feet of acetylene gas, which has many times the illuminating power of common illuminating gas. The light, moreover, is clear and "solid"—that is, it has not the unilluminated centre of an ordinary gas-light. Acetylene gas is readily solidified, and may be conveniently distributed in cylinders, like carbon dioxide and other gases.

THE Geographical Survey of the United States has issued the report of a party of department geologists who recently made an extended investigation and survey of the Cripple Creek region. The mining district is thirty miles west of Colorado Springs, and seventy-five miles south of Denver. It covers an area of six

miles in length by five and a half miles in width, between the two main ranges of the Rocky Mountains in Colorado. As long ago as 1874 it was thought that a big gold vein had been discovered near Mount Pisgah; and the second mining excitement was in 1884; but during these two periods not one of the really valuable ore bodies which are worked to-day was discovered. Rich ore was discovered in 1890, and the rush of miners began in 1892. The first gold in the district was produced in the latter part of 1891, and since that year the output has steadily increased, being variously estimated at 5,000,000 dols. to 7,000,000 dols. The ores of the Cripple Creek district are almost exclusively gold ores, with seldom silver enough to be important. The gold occurs both in a coarse and a fine condition, sometimes in particles so small as to be invisible to the naked eye, and at other times in plates or spongy masses from an eighth to a quarter of an inch in diameter. It is rarely clear and bright, and is generally coated with a thin rusty film of a yellowish-brown compound.

A GENERAL meeting of the Members of the Federated Institution of Mining Engineers will be held in Sheffield on Wednesday, February 19. Arrangements have been made for visits to cutlery and silverplate works and the technical schools in Sheffield on February 19, and to collieries and ironworks on the following day. The following papers are down for reading: "The Eastern Limits of the Midland Coal-field," by Prof. Ed. Hull, F.R.S.; "Electric Welding," by Mr. T. Scott-Anderson; "The Vibromotor as applied to the Screening of Small-coal," by Mr. Emerson Bainbridge, M.P.; "The Matabele Gold-fields," by Mr. F. G. Shaw; "Photography in the Technology of Explosives," by Mr. Alfred Siersch; "Lead and Lap of Winding and other Engines," by Mr. Hargrave Walters; "The Elliott Coal-washer," by Mr. J. Platt.

THE *Comptes rendus* for February 3 contain a paper by M. Maurain on the measurement of the energy dissipated in iron due to hysteresis. The amount of heat generated in a sample of iron when subjected to an alternating magnetic field is measured by enclosing the iron inside a cylindrical glass reservoir furnished with a capillary tube. This cylinder is filled with alcohol, and placed within a long magnetising coil. The reservoir being carefully protected from the heat generated by the passage of the current through the magnetising coil, the quantity of heat developed in the iron is deduced from the amount of the expansion of the alcohol. The development of heat due to Foucault currents is almost entirely prevented by using a bundle of very fine iron wires. The curve which gives, as a function of the time, the position of the surface of the liquid in the capillary tube during an experiment, consists of a straight line until the losses of heat due to radiation and conduction through the walls of the reservoir become appreciable when the line becomes curved. A preliminary experiment having indicated the form of this curve; in the final measurement care is taken that the observation does not extend beyond the straight part of the curve. The author finds that the quantity of heat developed during one cycle diminishes as the rapidity of the alternations increases. This diminution, however, becomes smaller and smaller as the frequency increases, and seems to be practically independent of the magnitude of the magnetising force. The author considers that the diminution observed is probably due to the screening action of the outside layers of the iron, and some experiments on which he is now engaged seem to favour this view.

THE number of the *Bulletin of Miscellaneous Information* of the Royal Gardens, Kew, for January, contains some interesting particulars of the effects on the Gardens of the long and severe frosts of the early months of 1895. These were in some respects different from what might have been anticipated from previous experience. Thus, while some herbaceous plants and shrubs reputed to be nearly hardy have perished, the laurustinus, the bay, and the arbutus escaped almost unharmed, as also did the evergreen oaks. "Alpines" suffered severely, though of course the cold was not so intense as the ordinary winter temperature to which many of them are exposed in their native habitat; but there they are protected through the winter by a covering of snow. The bamboos in the open ground were but little injured, while the pampas grass was largely killed. Of our native plants, the ling and the gorse were greatly damaged. Perhaps the greatest destruction was among the bulbs, of which very large numbers were entirely killed, especially the narcissi and hyacinths. In the same journal the number of visitors to the Gardens during 1895 is estimated at 1,407,369. This is about 30,000 more than the number for 1894, but somewhat less than the average numbers for the last ten years.

WE have received from Mr. J. Eliot, F.R.S., Meteorological Reporter to the Government of India, a preliminary discussion of certain oscillatory changes of pressure of long period and short period in India, being part ii. vol. vi. of *Indian Meteorological Memoirs*. The author points out that the discussion of pressure conditions in India requires that the observations should be of a high standard of accuracy, and for many years the greatest attention has been paid by the India Meteorological Department to the methods of observation, and to the critical comparison of the data. The first part of the paper deals with the normal conditions of pressure, and shows that the ordinary seasonal changes are very regular and uniform, while the abnormal conditions, such as are associated with the occurrence of storms, are, as a rule, very slightly marked. The largest regular oscillation is the annual change; the readings are highest in January, and fall until June, after which they rise until the end of the year. The amplitude of this change is smallest in Southern India, and increases with latitude. The smallness of the daily pressure changes is remarkable; only about five per cent. of the changes exceed a tenth of an inch. The second part of the paper deals in great detail with oscillations of pressure differing from the annual and diurnal changes, and which appear to be associated with atmospheric movements common to the whole of Southern Asia and the adjacent seas. In the long-period oscillations, the transfer of air across the equatorial belt tends during one half of the year to give an accumulation of air and high pressure over Central and Southern Asia, whilst in the other half of the year the air is drained away. The short-period oscillations are less regular than either the diurnal or annual, and approximately average four days in length. They appear to be common to the whole Indian area, and occur almost simultaneously; they are apparently not due to the transmission of waves in a horizontal direction, but possibly to waves of rarefaction and condensation, transmitted slowly upwards and downwards in the atmosphere, caused by variations of temperature. Although the discussion is only preliminary to a future paper, it teems with instructive matter which will well repay careful study.

A GOOD portrait of Lord Kelvin, reproduced by collotype, is presented as a supplement to *Industries and Iron* of February 7.

THE newly-established Société de Spéléologie of Paris has sent us the first three numbers of its quarterly journal, *Spelunca*. Accounts of caverns in various parts of the world are gathered together in the journal, several of them being illustrated by maps and other figures.

THE annual report of the New South Wales Railway Commissioners for 1894–95—being the final one for the original term of their appointment—contains, in addition to the ordinary very detailed statements, a full account of the extensive alterations and improvements made in the railway system since 1888. The

report is illustrated by maps, photographs, and diagrams; and the statistical tables are admirably compiled.

THE January number of the *American Geologist* contains an account of the late Prof. J. D. Dana, with a portrait and bibliography. Mr. Warren Upham discusses the flow of glacial ice, with especial reference to the views of Messrs. Fletcher and Deeley, mentioned in these columns about a year ago. A description of cases of the flotation of sand, by Mr. F. W. Simonds, and an essay on the use of Palæontology as "The Timepiece of Geology," by Prof. Claypole, are among the other contents.

THE *Annuaire* of the Municipal Observatory of Montsouris for this year has just come to hand; the observations—meteorological, chemical, and bacteriological—tabulated and discussed in it, refer to the year 1894. Another *Annuaire* which we have received is that of the Belgium Académie des Sciences, des Lettres, et des Beaux-Arts. A full notice of the life and mathematical works of Eugéne Charles Catalan, with a portrait, appears in this annual of the Brussels Academy.

WITH the motto *Magnus magnes ipse est globus terrestris*, the new international quarterly journal, *Terrestrial Magnetism*, the forthcoming publication of which was announced in these columns a few weeks ago, has made its appearance. The articles in the journal are: "On electric currents induced by rotating magnets, and their application to some phenomena of terrestrial magnetism," by Prof. A. Schuster; "Die vertheilung des Erdmagnetischen Potentials in Bezug auf Beliebige Durchmesser der Erde," by Dr. A. Schmidt; and "Halley's Earliest Equal Variation Chart," by Dr. L. A. Bauer, the map being reproduced in facsimile. There are also letters, notes, and reviews dealing with terrestrial magnetism and cognate subjects. The journal is published under the auspices of the Ryerson Physical Laboratory, University of Chicago.

WE have had upon our table for some time a copy of Napier's celebrated and rare work on the construction of logarithms—"Mirifica Logarithmorum Canonis Constructio"—reprinted in facsimile by M. A. Hermann, 8 Rue de la Sorbonne, Paris. Napier's discovery of logarithms was announced in his "Mirifici Logarithmorum Canonis Descriptio," published in 1614; but the explanation of the method by which the logarithms were calculated appeared in the "Constructio," a posthumous work not issued until 1620. To this work, which M. Hermann has now reprinted, Henry Briggs, who was one of the first to recognise the value of logarithms, appended some notes. The reprint will be valued by all students of the history of mathematics.

THE Geological Society of London has just published a list of the geological literature added to its library during the year 1895. As compared with the only previous issue in this form, we note that while the price remains unaltered, the volume has swollen to nearly threefold—an increase only partly accounted for by the fact that the present list represents a whole year's additions as against a half-year's in the previous one. The omission of maps from the list, to which we drew attention when the previous list was published, has been repaired; maps are entered under the names of the authors responsible for them in the general list, but there are cross-references under "Maps" in the subject-index. The publication will be found a most useful one by all geologists.

THREE papers were read at the recent meeting of the Institution of Mechanical Engineers, viz.: "Telemeters and Range-Finders for Naval and other Purposes," by Profs. Barr and Stroud; "Calculation of Horse-power for Marine Propulsion," by Lieut.-Colonel Thomas English; "Notes on Steam Superheating," by Mr. William H. Patchell. The paper by Profs. Barr and Stroud was confined to a description of two instruments, viz. (1) the range-finder which is now in use in the navies of this and many other countries; and (2) a small hand instrument, identical in principle with that for naval use, but much more portable and much simpler in its details. Lieut.-Colonel English's paper called attention to a method of calculating, from the results of a single sea-trial of one ship, the horse-power necessary to propel another ship, of the same type, at any required speed. By this method it becomes practicable, with the ordinary appliances of a shipyard, to approximate closely to results which could otherwise be obtained only by the use of the refined apparatus of a model tank. Mr. Patchell described a number of superheaters, and gave the results of tests with them.

THE additions to the Zoological Society's Gardens during the past week include a Klippspringer (*Oreotragus saltatrix*, ♂) from Nubia, presented by Commander Alfred Paget, R.N.; an Indian Wolf (*Canis pallipes*, ♂) from India, presented by Mr. Duncan Darroch; a Barn Owl (*Strix flammea*), British, presented by Mr. Bernard R. White; a Gould's Monitor (*Varanus gouldi*) from Australia, presented by Mr. Arthur R. H. W. Leach; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Jamaica, presented by Mr. Arthur P. Cohen; a West African Love Bird (*Agapornis pullaria*) from West Africa, presented by Mrs. Roberts; an Alpine Marmot (*Arctomys marmotta*), European, a Yellow-headed Conure (*Conurus jendaya*) from South-east Brazil, deposited; a Crested Grebe (*Podiceps cristatus*), a Curlew (*Numenius arquata*), British, purchased; a Malaccan Parrakeet (*Palæornis longicauda*) from Malacca, received in exchange; two Rufous Rat Kangaroos (*Hypsiprymnus rufescens*, ♂ ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE ASTROPHOTOGRAPHIC CATALOGUE.—At the last meeting of the Royal Astronomical Society, the Astronomer Royal gave some particulars relating to the progress at Greenwich of the international photographic star catalogue. A special staff for dealing with this work has been organised under Mr. Hollis, and already 130 of the plates taken for the catalogue have been measured. It is estimated that about 180 plates can be measured, and 160 of them reduced in the course of a year, so that at this rate the section allotted to Greenwich, comprising about 150,000 stars, will be completed in five or six years. Assuming that the other sixteen co-operating observatories are proceeding equally well, the world will soon be in possession of a colossal catalogue, comprising between two and three million stars.

ORBIT OF α CENTAURI.—Dr. Doberck, of the Hong Kong Observatory, has revised the elements of the orbit of α Centauri, which he determined in 1877, with the following results (*Ast. Nach.*, No. 3330).

Ω ...	$25° 25'$	T ...	1876·02
λ ...	$52° 53'$	e ...	0·51184
γ ...	$79° 14'$	P ...	79·123 years
μ ...	$4°·54987$	a ...	$18''·450$

The sum of the masses, as determined from these elements, is 2·3780 times the mass of the sun. Taking the parallax as $0''·75$ the major semi-axis is 24·60 times the earth's distance from the sun, so that the distances between the components are about the same as those of the outer planets from the sun in our own system. If the diameters of the stars are not very different from that of our sun, each would appear from the other as a mere star to unaided vision, the distance being too great to show a disc. An ephemeris up to 1920 is given in the paper, as well as a comparison of observations with the places calculated from the adopted orbit.

COMETS OF SHORT PERIOD.—From an interesting article on comets of short period, by Mr. W. E. Plummer (*Knowledge*, February), we extract the following table, indicating the comets which may with reasonable certainty be expected to reappear.

They are arranged in the order of the mean distances from the sun.

Name.	Period in years.	Date of last Perihelion passage.	Approximate date of next return.
Encke	3·303	1895, Feb. 4	1898, May 26
Tempel	5·211	1894, April 23	1899, July 10
Tempel-Swift ...	5·534	1891, Nov. 14	1897, May 28
Winnecke	5·818	1892, June 30	1898, April 25
Finlay	6·627	1893, July 12	1900, Feb. 26
D'Arrest	6·691	1890, Sept. 17	1897, May 27
Wolf	6·821	1891, Sept. 3	1898, June 30
Faye	7·566	1896, March 19	Now visible.

The mean distances of the comets from the sun range from 2·218 to 3·854, but the aphelion distances do not vary so greatly in proportion—a fact which suggests the controlling influence of Jupiter. It is remarkable that such a small number of regularly returning comets seem to be permanently attached to our system.

EFFECT OF SPOTS ON SUN'S DIAMETER.—Observations of the sun's diameter, made in the latter half of last year by J. Sykora, of the Charkow Observatory, have led to a result which may be of considerable importance if established by further investigations (*Ast. Nach.*, No. 3330). The observations were made with a 6-inch refractor by projecting the image of the sun together with that of the micrometer wires. The diameter measured in the direction of the points of appearance or disappearance of spot groups was found in the great majority of cases to be greater than the diameters in neighbouring parts of the sun as measured on the same days. Some of the results are as follows, the first column giving the diameter in the direction of spot groups, and the other two showing adjacent diameters:

	m. s.	m. s.	m. s.
June 22 ...	2 8·62 ...	2 8·38 ...	2 7·97
July 5 ...	8·37 ...	8·04 ...	8·21
,, 12 ...	8·30 ...	8·27 ...	8·27
Sept. 5 ...	8·52 ...	8·25 ...	8·44
,, 9 ...	8·41 ...	8·29 ...	8·36

It is concluded that although the spots themselves may be depressions, they produce an elevation of the surface of the sun in the regions where they are formed.

THE SPECULATIVE METHOD IN ENTOMOLOGY.

THE annual general meeting of the Entomological Society of London was held on January 15, the President, Prof. R. Meldola, F.R.S., being in the chair. After referring to the affairs of the Society and to the great literary activity of English entomologists during the past year, the President called attention to Mr. Oswald Latter's discovery of the secretion of potassium hydroxide by *Dicranura vinula*, &c., and to Mr. F. Gowland Hopkins's researches on the pigments of Pierine butterflies. The address then proceeded as follows:—

The association of chemistry and biology in researches such as those to which I have drawn attention, has suggested a comparison between the methods of research in vogue in the two great departments of science of which these two subjects are respectively typical. All science necessarily begins with observation or experiment, *i.e.* with ascertained facts, and it is perhaps unnecessary to assert that no mere collection of facts can constitute a science. We begin to be scientific when we compare and coördinate our facts with a view to arriving at generalisations on which to base hypotheses or to make guesses at the principles underlying the facts. Having formed the hypothesis we then proceed to test its accuracy by seeing how far it enables us to explain or to discover new facts, and if it fails to do this to our satisfaction we conclude that our guess has been a bad one and requires modification or replacing by a better one, *i.e.* by one more in harmony with the facts. I take it that the course of progress is the same in so far as these fundamental methods are concerned in both departments of science, the physical and the biological. It is possibly a matter of individual opinion as to how large a body of facts should be accumulated before we attempt to draw any general conclusions. There can be no doubt that the requirements of one branch of science cannot be measured by those of another branch to which it has no near relationship. But however large the number of facts, and however cautious or conservative the worker may be, it is an established doctrine taught by the whole history of science, that real progress only begins when we go to seek for facts armed with at least the suggestion of a principle if not with a complete theory based on facts already accumulated by observation or experiment. This is the whole difference between scientific observation or experiment and mere random or haphazard observation. A naturalist of the old school, William Swainson, writing in 1834,[1] speaks of the "observance of nature, without making any attempt to generalise the facts so acquired," as "a mere amusement, fascinating indeed, and even useful, but totally disconnected with the objects of philosophic science." Now I venture to think that entomology in this country has been retarded in its development for want of a little more of this "philosophic science"; by an unwillingness on the part of our most active workers to give rein to the imagination—by an overcautiousness which is damping to the speculative faculty. There are no doubt many present who will not agree with this view, but I claim indulgence while I state my case in its support. It will, I think, be conceded that we have passed beyond the mere fact-collecting stage. It appears to me that in entomology we have arrived at a state where we are suffering from a plethora of facts; if we are not in a position to explain everything connected with the development, life-histories, instincts, classification and distribution of insects as a class of animals, we are at any rate in a position, speaking paradoxically, to know what we want to know, and I do not see how we are going to advance unless a more generous use is made of hypothesis as a scientific guide. It is this point which I desire to urge and to show that there is no real danger in boldly facing what the late Dr. Romanes aptly calls the bugbear speculation.

In the first place, with respect to the physical sciences, there is abundant justification for the view which I am advocating. We have there long ceased to collect random facts; observations and experiments are suggested by hypothesis. That prince among experimental philosophers, Michael Faraday, was wont to say: "Let us encourage ourselves by a little more imagination prior to experiment." The state of affairs is well summed up in one of the latest works on chemistry in which the author, in introducing the fundamental principles of modern investigation says:

"The history of the exact sciences teaches us that we may discover new laws of nature in two essentially different ways, one of which may be designated as the empirical, the other as the theoretical. Thus in one way by suitable observations, one collects abundant material . . . and then by a repeated and purely empirical grouping of the data so obtained, he seeks to approach the desired goal. . . . The second way, on the other hand, leads from suggested conceptions regarding the nature of certain phenomena, through pure speculation to new information, the correctness of which must be determined by a subsequent research."[2] One other recent utterance by my colleague, Dr. W. M. Hicks, the President of Section A at the last Ipswich meeting of the British Association, will serve to give us a glimpse into the spirit of progress in pure physics: "By our imagination, experience, intuition, we form theories; we deduce the consequences of these theories on phenomena which come within the range of our senses, and reject or modify and try again. It is a slow and laborious process. The wreckage of rejected theories is appalling; but a knowledge of what actually goes on behind what we can see or feel is surely, if slowly, being attained. It is the rejected theories which have been the necessary steps towards formulating others nearer the truth."[3]

And now let us consider how far these methods, recognised as valid in the physical sciences, are applicable to the biological sciences, of which entomology constitutes a branch. Of course, I am not claiming for our subject the position of an exact science, and to suppose that it could be advanced by purely deductive methods would be absurd. But I am endeavouring to hold the balance between a more liberal use of the speculative method, on the one hand, and the deadening influence of refusing to speculate at all, on the other hand. I am putting forward a plea for an increased use of the imagination, because I hold that

1 "Preliminary Discourse on the Study of Natural Science," p. 51.

2 "Theoretical Chemistry," by Walter Nernst, translation by Prof. Palmer, 1895, p. 2.

3 Address to the Mathematical and Physical Section of the British Association, Ipswich 1895.

the time has arrived when this may—nay, must be allowed, if our science, with its immense wealth of raw material, is to take that rank to which it is entitled among the departments of modern biology. If, as is undoubtedly the case, the speculative method has been found fruitful in other fields of natural history, it behoves us as co-workers in the great battle for truth to re-examine our weapons—to ask ourselves seriously whether the time and energy of our most active workers is being utilised in the best way for the advancement of knowledge.

To many it may appear that the use of hypothesis as a guide to investigation is so obvious, that no special advocacy is required. All I have to say, in this case, is to express the earnest wish that the Fellows of this Society who hold such a view may be numerous—the more numerous the better. I will venture to remind you, however, that my predecessor in this chair has stated, with respect to this method of handling entomological problems:

"I feel, however, for myself, and I think that others must also feel, that however great and important is the knowledge which we may ultimately attain, by endeavouring to discover the laws which govern the development, variation, and distribution of insects, the knowledge we have of the actual facts is in many cases quite insufficient to bring such speculations to a definite end. I also feel that the number of persons whose talents are sufficiently great to enable them to steer a straight course through the numerous difficulties, contradictions, and doubts which constantly surround such inquiries is very limited" (*Proc. Ent. Soc.* 1893, p. xlvi.).

I am sure Mr. Elwes will not ascribe any personal motive to me in making use of this passage, as representing the views of what may be called the conservative school of entomologists. I feel only too acutely the truth of his remark that many agree with him in this opinion; at the same time I am sanguine enough to believe that there are many who do not, and on behalf of this constituency I have felt it a duty to urge a claim for the speculative method, not as displacing the older method of collecting and recording facts altogether, but as a stimulus to more systematic investigation, rendered imperative by the general advance of biological science. For my own part, I believe that the time has gone by when every attempt at discovering natural law in the organic world by the aid of entomological observations, is to be met by this prevalent cry of *non possumus*.

If we turn to results as a measure of the value of methods, it will, I imagine, be conceded that we can show good cause in favour of theorising. I may be permitted to draw some illustrations from the Lepidoptera, the only order to which I can lay claim to some slight special knowlege, and in which our former President is a recognised authority. In the following remarks I desire most emphatically to dissociate myself from controversial matters, because my sole aim in this address is to clear the atmosphere for the more healthy use of the speculative faculty by our younger and rising workers. I wish it to be understood that in speaking of any particular hypothesis, I am not now raising the question of its soundness or unsoundness—that is, logically, a distinct issue—but I am simply adducing the hypothesis in order to illustrate the results of its introduction into modern scientific thought. I begin with the phenomena of mimicry and protective resemblance among butterflies and moths as first explained by our late distinguished Fellow and past President, Henry Walter Bates, in his memorable paper of 1861, which was followed by the well-known memoirs of Wallace and Trimen on the same subject. It will be remembered by all who are familiar with the history of the subject, that this was the first application of the theory of natural selection of Darwin and Wallace to explain a new set of phenomena. It was a speculation evolved by Bates, not when collecting in the Amazon Valley, as is generally supposed, but while looking over his specimens when he had reached London, and was pondering, at his own fireside, over the meaning of the remarkable superficial resemblances among the butterflies of different groups which he had brought home.[1]

The Batesian theory was fruitful; it carried with it the explanation of the resemblance between insects of distinct orders and of the assimilation of insects and other animals in colour and form to the objects among which they lived; it prompted further observation and experiment because more evidence was required as to the protected character of the insects which were copied; it raised the whole question of the existence of such protected species in nature, and the question has been answered so far in the affirmative, although there is still a large field for further experimental observation waiting to be explored. The facts have increased enormously since 1861, the search for new instances having been stimulated by the explanation suggested by Bates, and the systematist is now no longer in danger of being deceived by superficial resemblances.

The theory of Bates left unexplained the resemblance between species belonging to protected groups to which he had himself called attention in his original paper: an extension was required and was made by our Hon. Fellow, Fritz Müller in 1879, and as a result, whether this extension be considered valid or not—a point which I am not now raising—the systematist is now more fully alive to the superposition of external similarity upon structural resemblance due to true blood-relationship, as can be seen from the writings of Moore on the genus *Euplœa*, and of Wood-Mason and others on certain Papilionidæ. As another result of Fritz Müller's hypothesis, the question of inherited knowledge of edible and inedible species on the part of insect-eating creatures has likewise been raised, and has already led in the hands of Prof. Lloyd Morgan to some interesting experimental conclusions.

As the product of a theory we thus have a large body of real and tangible knowledge gleaned from nature! Mere casual observation would never have revealed the widespread existence of the phenomenon if the stimulus to look out for it had not come from the theoretical side.

It is not the bare record of the comparatively few cases of mimicry that constitutes the highest value of these classical memoirs—it is the speculation, the hypothesis, the suggested *cause* of the phenomenon that has given vitality to what would otherwise have been a disconnected and meaningless set of facts. But the consequences of the introduction of the theory of natural selection into the subject of insect colouration have not yet been exhausted. From the observation that the species which are mimicked are generally gaudily coloured and take no special means to hide themselves, it is but a step to the well-known theory of warning colours propounded by Wallace in 1867. That theory, in itself the outcome of a question raised by Darwin in connection with his theory of sexual selection, stimulated the experiments of the late Jenner Weir and of A. G. Butler, the striking observations of Thomas Belt in Nicaragua, the detailed researches of Weismann into the origin and meaning of the colours of caterpillars, and the later systematic series of experiments conducted by Poulton. Yet another example I will permit myself to make use of because it is one in which I have some personal interest. In considering the subject of adaptive colouration as explained by Bates and Wallace, a difficulty occurred in the case of species which are of variable colouring: I ventured to suggest, as far back as 1873, that this kind of colouring would be explicable by natural selection, if we supposed that this agency could confer a power of adaptability on the individual. At that time no mechanism could be conceived of by which such individual adaptability could be acquired, excepting the direct assimilation of the colouring-matter of food-plants in the case of caterpillars or other vegetable feeders. This, of course, carried with it the implication that natural selection could work on physiological processes if they were of use, just as well as upon any external morphological character. Stimulated by this hypothesis, other cases of variable colouring were sought for and found. The subject was later taken up by Prof. Poulton, who, for many years, conducted experiments and obtained results which are now familiar to all naturalists. The original speculation, that variable colouring was the result of an individual adaptability due to natural selection, implies that this faculty is of bionomic value. I am not now concerned with the validity or otherwise of this assumption; that is an issue on which opinion appears to be divided; although, I have no doubt in my own mind on the point, it is not necessary to state the case with any bias on the present occasion. Now the experiments of Poulton have shown that this colour variability is of very much more frequent occurrence than was ever dreamt of in 1873, and his facts have, in the main, been substantiated by the independent observations of many other experimenters. And it turns out also that the mechanism of the process is not even the simple assimilation of colouring-matter from the food-plant, excepting in the case of green caterpillars, in which it has been shown that chlorophyll in a modified form passes into the blood. The colour variability of caterpillars and pupæ in response to the external stimulus exerted by coloured surfaces, as established by these experiments, has brought us face to face with a fundamental

[1] I owe this statement to Mr. Bates himself, who has often made it to me.

problem in insect physiology, the solution of which we are anxiously awaiting. The mere possibility of being able to state the problem in its present form—apart from any question of the adaptive value of the colouration—is a step forwards; is an incentive to further experiment, and this is the legitimate end and aim of all scientific speculation.

Were I to attempt, however, to pass from what has already been accomplished to that which is yet awaiting investigation—to the questions which rise on all sides as pressing for solution, there would be no limit to this address. In view of the splendid opportunities afforded by insects for treatment as living organisms capable of revealing natural laws by skilled experimental research, is it not pardonable if we sometimes give way to the unphilosophic thought that the possession of chitinous exoskeletons by these creatures, whereby they lend themselves so admirably for preservation as cabinet specimens, is an arrangement expressly designed for the retardation of entomological science? The scientific workers at living insects in this country are deplorably few as compared with those who devote themselves to cabinet entomology. The one great desideratum of modern biology is an experiment station where protracted observations can be carried on year after year on living animals, each set of experiments prompted by hypothesis and with the definite object of answering some particular question in relation to variability and inheritance, the nature of the action of the environment, the effect of selection, &c. This was a dream of the late Dr. Romanes; he has not lived to see it fulfilled, but if it should be realised in our time our entomologists will, I venture to hope, not be behind with suggested lines of work.

If by way of comparison we now turn to that branch of the subject in which the empirical method has hitherto almost exclusively been employed, viz. the taxonomy of this same order Lepidoptera, the results are most instructive. In view of the immense body of facts, the number of named species and the mass of published descriptive matter, I do not think I shall be wrong if I say that the best energies of the acutest workers have been concentrated on this subject from the middle of the last century down to the present time. A record of nearly a century and a half against the thirty odd years that have elapsed since the introduction of the theoretical method into the biological sciences. Is there any indication that all this work has brought us nearer the "definite end" to which it was and is directed—the natural classification of the Lepidoptera—to an extent commensurate with the number of workers and the time bestowed upon it? It is only quite recently that any decided advance has been made, and that through the work of Hampson, Comstock, Chapman, Meyrick, and others. It cannot be said that we have been waiting all these years for materials—for a few thousand new species is one of the best "collected" groups in the whole world of insects—in order that this sudden rush might be made. I take the view that we have been waiting rather for method than for additions to the lists of species; that we have hitherto too much disregarded the spirit of the speculative method in our taxonomic work, and that we have now happily found a band of workers who refuse to submit to the plea of inability because all the existing species of Lepidoptera have not been collected and named.

After advancing these arguments in favour of a more liberal use of the "scientific imagination" in connection with entomological subjects, I feel it incumbent upon me to define the position a little more fully in order to prevent misunderstanding. The conditions of speculation in the two great departments of natural science which have been under consideration are not exactly the same, and the differences in the method of treatment must not be lost sight of. If in the physical sciences there is, to use the expression of the late Prof. Stanley Jevons, "unbounded license of theorising," it is because we can appeal to nature so readily by the experimental method, and get our answer one way or the other, by imposing rigid conditions which are under our control. In the biological sciences this is not the case; all who are acquainted with experimental work in biology know how difficult it is, generally, to get definite answers to our questions—the conditions are vastly more complex when we come to deal with living organisms. I remember once remarking to the late Mr. Darwin how difficult it was to get nature to give a definite answer to a simple question, and he replied, with a flash of humour: "She will tell you a direct lie if she can." The practical result of this difference is that the speculation of an hour may take a lifetime for its verification. But I see no reason why, on these grounds, we should repress the spirit of speculation. If, as our former President says, it is given to few to be able to speculate with advantage—and in this I thoroughly agree with him—it is our paramount duty for the present and future welfare of our science, to give every man's honest thought our most serious attention, and to encourage the faculty whenever and wherever we find it, as the most precious means of advancing scientific knowledge. The "bugbear" is a very harmless animal if you look him boldly in the face, and if you treat him gently and put him into harness he will drive the chariot of science for you at a speed that will leave the empirical method far behind in the race for the knowledge of nature's ways.

The great service which the founders of the modern doctrine of evolution have rendered to science has, in my belief, been not only the particular theory of species transformation with which their names will ever be associated, but the importation into biology of the methods of the physical sciences. Writing to Wallace, in 1857, Darwin said: "I am a firm believer that without speculation there is no good and original observation" ("Life and Letters," vol. ii. p. 108). In the same letter he remarks: "You say that you have been somewhat surprised at no notice having been taken of your paper in the *Annals*. ["On the Law that has regulated the Introduction of New Species," *Ann. and Mag. Nat. Hist.*, 1855.] I cannot say that I am, for so very few naturalists care for anything beyond the mere descriptions of species." This statement of 1857 does not hold good in 1896; other methods of biological research have been introduced—the road to biological fame is no longer through the sole channel of technical systematic work, and we owe it to the writer of that letter more than to any other worker and thinker of our time, that the horizon has been extended on all sides.

The misapprehension to which my remarks may possibly give rise, and which I am most anxious to prevent, is that in urging the claim of the theoretical method I am introducing the danger of rash and promiscuous speculating by all kinds of dabblers in the subject. There is much justification for this attitude, but an analysis of the supposed danger will, I think, serve to show that it is not a very formidable one after all. It appears to me, moreover, that the advantage of giving an impetus to observation along preconceived lines far outweighs any passing danger arising from hasty speculation. It is notorious in the history of modern science that no single branch has escaped the efforts of well-intentioned, but quite irresponsible outsiders, to set our various houses in order for us. On critical examination it will be found, however, that none of these attempts, even when they have been lucky enough to forestall the conclusions arrived at by legitimate methods, have led to any practical issue in the way of observation or research. I am addressing my remarks on the present occasion to a Society composed more or less of experts; I am not inviting "the man in the street" to favour us with his views on this, that, or the other question, but I am asking the working entomologists among us to bear in mind that their studies may be directed so as to throw light on some of the broad biological problems of the day, if they will, as Faraday said, encourage themselves by a little more speculation. Judging from the part played by this method in the development of modern science, it is perhaps not going too far to say that it is better to have speculated erroneously than never to have speculated at all. Illustrations might be adduced showing that erroneous theories have often done good service to science, and that for this reason they have been temporarily retained, even when recognised as inadequate to meet the growing body of new evidence. This was the case, for example, with the old "fluid" theory of electricity. So also the "corpuscular" theory of light enabled Newton to develop optical science to a remarkable extent, although this theory is now among what Dr. Hicks calls the "wreckage."

Another source of danger in biological speculation to which I am also alive, is that we have the public eye upon us to an extent that is not experienced in other departments of science. I am bound to confess that I never could quite make out why this should be the case. It is possible to speculate about the constitution of matter, the degradation of energy, the age of the solar system, and other great problems of the universe, with any degree of dogmatism without exciting public discussion. But as soon as ever an effort is made to explain something in the living world, no matter how modestly, the speculator is forthwith treated as though he had thrown down a public challenge. Perhaps it is for this reason that biology is more subject to

unauthorised and unscientific intrusion; because it gives opportunity for the pure *littérateur* to pose as a theorist. The speculations of the physicist or chemist are, moreover, generally expressed in a symbolical language which is not understood by the public at large, and their ideas, however revolutionary, thus escape newspaper and magazine notoriety. As far as my reading extends, I am inclined to believe that even in the case of the purely literary treatment of biological problems by writers who are not experts, the danger of overweighting the science with hypothesis is much exaggerated. Writers of this class are often capable of taking a wider and more philosophic grasp of a problem than a pure specialist, and ideas of lasting value have sometimes emanated from such sources. I imagine that nobody will dispute that Mr. Herbert Spencer's writings have largely influenced the public mind—whether we agree with the details of his doctrines or not—in accepting the broad principle of evolution, although this profound thinker lays no claim to an expert knowledge of any branch of natural history. But every working naturalist can ascertain for himself the credentials of any particular writer: my remarks are simply offered with the object of claiming more consideration for such writers, as a class, on the part of practical workers. The philosophic faculty is quite as powerful an agent in the advancement of science as the gift of acquiring new knowledge by observation and experiment. It is not often that the faculties are combined in one individual.

The general conclusion to which these considerations point is that the biological theorist, by virtue of the complexity of the factors, the difficulty of experimental verification, and the tendency on the part of the public to mistake tentative hypotheses for established theories, should put forward his views with more explicit caution than is necessary in the case of the physical sciences, where experimental evidence is more easily obtainable, and where the self-constituted philosopher but rarely gets a hearing. All this amounts, however, to nothing more than a plea for caution, and not for total abstinence. To disallow speculation because a complete theory cannot be formed out of the existing materials, is simply to put a check upon legitimate advancement. I freely admit that it is possible to carry speculation to an unscientific extreme—to fritter away a plausible hypothesis by mere metaphysical discussion, or to bury a real and important issue under an incubus of verbiage. But this is not the legitimate use of the speculative method; it is an accident, which the scientific worker will know how to avoid, and which is contingent upon the present condition of biological investigation. We cannot test our speculations off-hand by a few crucial experiments, as in physical science, and in the meantime the logic-chopper may get hold of our idea and whittle it away. On these grounds, however, I again fail to see any reason for repressing speculation. It might as well be argued that because the action of fire, carried to an extreme, carbonises organic matter, we should therefore eat our food raw. The irresponsible manipulation of biological hypotheses by pure speculators does no real or permanent injury to the cause of science, and may indirectly do good by directing public attention to the work which is being carried on. I rather think the absence of public sympathy, in connection with theoretical research in chemistry and physics, exerts a depressing influence; the inventor of a new hypothesis in these subjects moves entirely in an atmosphere of his own creation, which even his colleagues seldom venture to penetrate. That biological speculations are more prone to such unauthorised treatment is no more a reason for refusing to speculate than the circumstance that generations of fact-collectors have wasted their time in amassing large stores of disconnected observations, which for want of system are practically of no avail to the scientific worker, is an argument in favour of repressing observation. It is possible to be quite as unscientific in the accumulation of facts as it is to become metaphysical by over-speculation; there is as much danger in one direction as there is in the other. Yet the most ardent advocate of the theoretical method has not taken it upon himself to declare that observation must cease until he has explained all the facts at present available. This, however, is practically the position taken up by those who refuse to recognise that existing knowledge is sufficient to enable considerable advance to be made by the legitimate use of the theoretical method.

One other point demands consideration, in conclusion. If latitude for the exercise of speculation is to be allowed, where, it may be asked, is the line to be drawn? How are we to distinguish between the cautious theoriser and the writer who permits himself "unbounded license?" These are questions to answer which requires nothing but an exercise of individual judgment. A sound speculation may emanate from the happy possessor of a philosophic mind although he may never have done any technical biological work. But this kind of speculator naturally fails to secure that hearing to which the practical worker is entitled. Although valuable generalisations may occasionally be given out by great thinkers, the expert biologist shows wisdom in giving his most serious attention only to those who are familiar with their data at first hand—who have themselves gleaned their information directly from nature. By such workers only can the true value of the evidence be fairly weighed and estimated. I should be very sorry if the remarks which I have ventured to offer in the course of this address were to be interpreted into a general public invitation to speculate on biological problems. But I do raise the question here as to the kind of biological work which is to be recognised as a fitting preparation for the exercise of the speculative faculty. It used formerly to be asserted that he only is worthy of attention who has done systematic, *i.e.* taxonomic, work. I do not know whether this view is still entertained by entomologists; if so, I feel bound to express my dissent. It has been pointed out that the great theorisers have all done such work—that Darwin monographed the Cirripedia, and Huxley the oceanic Hydrozoa, and it has been said that Wallace's and Bates's contributions in this field have been their biological salvation. I yield to nobody in my recognition of the value and importance of taxonomic work, but the possibilities of biological investigation have developed to such an extent since Darwin's time that I do not think this position can any longer be seriously maintained. It must be borne in mind that the illustrious author of the "Origin of Species" had none of the opportunities for systematic training in biology which any student can now avail himself of. To him the monographing of the Cirripedia was, as Huxley states in a communication to Francis Darwin, "a piece of critical self-discipline,"[1] and there can be no reasonable doubt that this value of systematic work will be generally conceded. That this kind of work gives the sole right to speculate at the present time is, however, quite another point. It might be argued with some show of reason that exclusive devotion to systematic work cripples the imaginative faculty.[2] The methods of attacking the problems connected with living organisms have been increased and improved from every side, and the anatomist and physiologist, the morphologist, the embryologist, the student of bionomics, have all an equal claim to contribute to biological theory. The particular problems relating to the transformation of species are no doubt best dealt with by those who, by systematic work, have acquired a true notion of what is meant by the term "species." But so far as entomology is concerned, it must be confessed that the greater part of our systematic work has emanated from cabinet entomologists, who know nothing of the species they describe as living organisms by direct observation, and to me it appears doubtful whether this kind of work does confer any special faculty of speculating with advantage on the species question. It seems rather that the "field-naturalist" in the old sense of the term has the advantage, and I may remind you in this connection that during the voyage of the *Beagle*, when Darwin began to make those observations on island life which afterwards led him to take up the question of species transformation, he was essentially a "field-naturalist," his systematic work on the Cirripedia not having been commenced till after his return. So also Wallace, at the time when he independently elaborated the theory of natural selection, was certainly not a systematist in this narrow sense. He has been good enough to favour me with his views on this point, in a letter dated December 31, 1895, in which he says: "I do not think species-describing is of any special use to the philosophical generaliser, but I do think the collecting, naming, and classifying some extensive group of organisms is of great use, is, in fact, almost essential to any thorough grasp of the whole subject of the evolution of species through variation and natural selection. I had described nothing when I wrote my papers on variation, &c. (except a few fishes and palms from the Amazon), but I had collected and made out species very largely, and had seen to

1 "Life and Letters," vol. i. p. 348. Even in the days of my studentship, Huxley lectured on Natural History at the Royal School of Mines with the aid of diagrams and specimens only: practical work in the laboratory was unknown.

2 See a letter from Darwin to Bates in 1861, "Life and Letters," vol. ii. p. 379.

some extent how curiously useful and protective their forms and colours often were, and all this was of great use to me."

I had hoped to be able to discuss some of the current problems which are before biologists, and towards the solution of which entomology might contribute largely. Such, for example, are Galton's and Weismann's views on the non-transmissibility of acquired characters, the *rôle* of what Mr. Bateson calls "discontinuous variation" in the origin of species, the recent efforts to throw light on the all-important subject of variability by the statistical methods introduced by Galton and now being worked at from the experimental side by Weldon, and from the mathematical side by Karl Pearson. I feel, however, that I have trespassed already too long upon your forbearance, and while again thanking you for the honourable position in which you have placed me, I can only express the hope that my special plea for a more liberal use of the speculative method among our working entomologists will not be regarded by those who hold different views as a breach of the privilege of that office to which by your courtesy I have been elected. Should there be any who entertain this opinion, I beg them to make a liberal discount for personality, and they will find that the ultimate motive has been to promote the best interests of our science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Waynflete Professor of Mineralogy (Mr. H. A. Miers), who has been absent during the early part of the term through illness, announces a course of lectures on Elementary Crystallography.

In a Congregation held last week, the proposal that a sum not exceeding £150 per annum for three years from October 1, 1894, should be applied out of the Common University Fund in maintaining a scholarship to be held by a student at the Marine Biological Station at Naples, was agreed to, *nemine contradicente*.

In a Congregation to be held on February 18, a form of statute amending the provisions of a statute made for the administration of the Lichfield Trust for Clinical instruction, will be proposed. The object of the statute is to provide for the conduct of the Pathological Department at the Radcliffe Infirmary by the Regius Professor of Medicine, or a person appointed by him, and for giving instruction in Pathology in accordance with the Regulations of the Board of the Faculty of Medicine.

The interest of the University is at present absorbed in the resolutions respecting the admission of women to the degree of B.A., which are to be submitted to Congregation on March 3. The first resolution, which proposes that women shall, under certain conditions, be admitted to the degree of B.A., will if carried tend to promote the study of every subject by women in Oxford, and therefore has an ultimate bearing on scientific studies. At the same time it will compel women to go through Responsions and the other examinations from which they are now exempt. There are some who think that this will be injurious to their interests. The most that can be said in the case of those who wish to read Natural Science is, that it will compel them to learn Latin and Greek either before they come to Oxford, or after they have come up. If the latter, they will find themselves obliged to keep four years residence, which most do not as things now are. If they know enough Latin and Greek to pass Responsions before coming into residence, their case will not be altered, for a woman competing for honours in one of the final subjects in the Honour School of Natural Science always passes the preliminary examinations required by the statutes in the case of men. It is not proposed that the strict B.A. course should be obligatory on all women students. Those who do not wish totake up Latin and Greek, but wish to read Natural Science or another subject such as History, will be allowed to do so under existing regulations, and so may escape Responsions; but they will also have to forego the distinction of the degree.

CAMBRIDGE.—St. John's College has made arrangements for the admission of post-graduate students desiring to pursue a course of advanced study or research under the new regulations of the University. Until the statutes now before the Privy Council are approved, candidates for admission are required to present a letter of recommendation from the Professor or other teacher under whom they propose to work in Cambridge. Further particulars may be learned on application to one of the tutors of the College.

Mr. J. N. Langley, F.R.S., Lecturer in Physiology, has been approved for the degree of Doctor of Science.

T.R.H. the Grand Duke of Hesse and Prince Henry of Prussia have presented to the Museum of Zoology the skeleton of a wild boar.

The following have been appointed Electors to the undermentioned professorships: Chemistry, Prof. Thomson; Plumian (Astronomy), Sir G. G. Stokes; Anatomy, Downing (Medicine), Surgery, and Pathology, Prof. Foster; Botany and Physiology, Prof. Allbutt; Geology, Dr. Phear; Mineralogy, Prof. Liveing; Zoology, Mr. J. W. Clark; Experimental Physics, Prof. Clifton; Mechanism, Mr. Horace Darwin.

A MEETING was held at Cardiff last week to start a public subscription in aid of the erection of new buildings for the University College of South Wales. A sum of £20,000 is required to meet the conditional grants made by the Treasury and the Drapers' Company. Contributions amounting to £13,000 were promised at the meeting. Lord Windsor, who presided, will contribute £2500, and a substantial sum has also been promised by Lord Tredegar. It is expected that £30,000 will be raised. Mr. Alfred Thomas, M.P., contributes £1000, and Mr. John Cory a like amount.

Science announces the following gifts to education in America: The University of Pennsylvania has received a gift of 5000 dols. from Mr. Charles M. Swain, and of 5000 dols. anonymously, the money to be used without restrictions. The will of the late Martin Brimmer, of Boston, to take effect on the death of his wife, bequeaths 50,000 dols. to Harvard University. Ground has been broken for the first of the four buildings of the new biological school of the University of Chicago, which is to be erected with part of the 1,000,000 dols. recently given by Miss Culver. It is proposed to erect special buildings for zoology, botany, anatomy, and physiology, instead of one biological building, as planned before the receipt of Miss Culver's gift.

PRINCIPALS of Technical Schools and others who assist in deciding the character of instruction in chemistry, would do well to take to mind the lesson contained in the following extract, referring to the work of the Chemical Department, from the programme just received from the Central Technical College: "The object aimed at in this part [first year] of the course will be to encourage habits of accuracy and thoughtfulness, and to teach the art of experimenting with a logical purpose rather than to impress mere facts. . . . As soon as students have acquired the necessary proficiency as analysts and sufficient skill in preparing pure substances, they will be encouraged to undertake an original investigation, in order that they may learn to apply their knowledge, as well as develop their powers of observation and reasoning: and thus become fitted to solve problems which are continually presenting themselves in practice, and to improve and advance the industry with which they may be connected. The importance to students of thus devoting themselves, sooner or later, to the higher branches of chemistry cannot be too strongly insisted on; in no other way is it possible for them to acquire the breadth of view and the power of grappling with new problems, as they arise in practice, which are required of the technical chemist."

DR. H. E. ARMSTRONG has been for some time trying to instil a little scientific spirit into the School Board for London. In an address recently delivered at the Borough Polytechnic Institute, and printed in full in the *Technical World*, he described the excellent results attained by the introduction of the scheme of instruction in scientific method, drawn up by a Committee of the British Association. The Board has every reason to be proud of what its science demonstrators have done to promote the reformed methods of science instruction, of which Dr. Armstrong is the most active exponent. The methods have been proved to be practicable, and the results obtained by following them are most satisfactory. It remains for the School Board to recognise this by extending to all its schools in the metropolis (girls' as well as boys' schools) the teaching which has been so successfully carried on in one of its districts. If that were done, a great advance in education would be assured. Those who are engaged in the work of technical education are agreed, as Dr. Armstrong pointed out, that it is all but impossible at the present time to give true technical education in this

country, owing to the extraordinary defective condition of our preliminary school training. But if children in elementary schools were taught to appreciate the main principles of scientific method, it would be possible for them afterwards to properly avail themselves of the higher training which is offered to them, and which alone can render them competent as industrial and domestic workers. It is to be hoped, therefore, that the School Board will see its way to extending the work of scientific education begun under its auspices six years ago.

IN a preliminary report recently prepared for the Technical Education Board of the London County Council, Dr. C. W. Kimmins gives the following statistics to show the progress that has been made, especially in the teaching of physics and chemistry, in the secondary schools assisted by the Board.

	1893–4.	1894–5.	1895–6.
Number of pupils receiving theoretical instruction in physics	1867	1899	2266
Number of pupils doing practical work in physics	215	433	1576
Number of pupils receiving theoretical instruction in chemistry ...	2091	2287	2647
Number of pupils doing practical work in chemistry...	630	1101	1814
Percentage of those receiving theoretical instruction in physics, taking practical work in this subject	11·5	22·9	69·5
Percentage of those receiving theoretical instruction in chemistry, taking practical work in this subject	30·1	48·1	68·5

Dr. Kimmins points out that the statistics show that there has been a general advance in the number receiving instruction in experimental science at these schools, and that the proportion doing individual practical work has increased to a far greater extent. He reports that the general introduction of practical teaching in elementary physics is producing excellent results. A marked improvement is also to be noticed in the teaching of chemistry; the practical work is of a much more rational kind, and bears a closer relation to the class teaching. Qualitative analysis is rapidly ceasing to occupy the important position it has held in the laboratory in former years.

SCIENTIFIC SERIALS.

THE *Journal of Botany* commenced its enlarged issue with the present year, and the two numbers already published indicate that its editor will have no difficulty in filling its pages with matter of value to the English botanist. An interesting paper, by Mr. E. A. L. Batters, describes several new British seaweeds, including two new genera, *Colaconema* and *Traillicila*, both belonging to the *Florideæ*. Mr. J. H. Burkill contributes a paper on the variation in the number of parts of the flower of *Parnassia palustris*. Mr. A. H. Praeger proposes a division of Ireland into botanical districts, accompanying his paper by a map. There are a number of other papers on various departments of descriptive botany. The plates illustrate two new forms of British pond-weed described by Mr. A. Fryer, and new African plants described by Mr. A. B. Rendle and Mr. E. G. Baker.

Bulletin of the American Mathematical Society, vol. ii. No. 3, December 1895.—Prof. F. Morley, in a notice of Gundelfinger's Vorlesungen aus der Analytischen Geometrie des Kegelschnitte, classes it with two other recent analytic works on conic sections, for which one is very thankful; the other two are the works by the late Prof. Casey and Miss Scott. He states the plan of Gundelfinger's treatise to be to systematically develop the theory by means of homogeneous coordinates, while bringing out the fact that the elementary (x, y) system is merely a case to which we can descend when so minded. This latter may seem a minor point; pedagogically it is not so, and it is certainly not well explained in many books. The development of the theory is really analytic, though one feels that the analysis is under the control of a masterly geometric insight. Prof. Morley's review is a long one, and enters into many details of the work which has been edited by Dr. Dingeldey. Short notes follow, viz. on divergent series, by Prof. A. Chessin, and a simple proof of a fundamental theorem of substitution groups, and several applications of the theorem, by Dr. G. A. Miller.—Dr. James Pierpont contributes an interesting note on an undemonstrated theorem of the *Disquisitiones Arithmeticæ*. This ends with two theorems relating to the construction of a polygon of n sides by a series of *rational* conics, *i.e.* conics whose coefficients are rational in the current domain of rationality, and gives in three rows the polygons, constructible by rule and compass, known to the Greeks (twenty cases); then the polygons of this class discovered by Gauss (five cases); and, in the last row, the *additional* polygons which can be constructed when *rational* conics can be employed (thirty-five cases). The table is limited to constructible regular polygons of sides $\overline{\gtrless}$ 100.—Notes and new publications close the Number.

Bollettino della Società Sismologica Italiana, vol. i. 1895, No. 7.—Ernesto von Rebeur-Paschwitz, by A. C.—The first instant of the great earthquake-shock of May 18, 1895, noted in Arcetri (Florence), by A. Abetti.—On the Florentine seismic centre, by M. Baratta. A topographical discussion of the three principal earthquakes felt in the neighbourhood of Florence in the present century, those of 1812, 1887, and 1895. The centres of the meizoseismal zones, though very near one another, are not quite coincident; but this, it is suggested, may be due to a variation in the depth of focus, or in the intensity of the original disturbance.—Notices of earthquakes felt in Italy (May-June 1895), by M. Baratta. The most important are the Florentine earthquake of May 18, the Spoleto earthquake of May 20, and the Rovigo earthquake of May 25.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, January 16.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—The acetylene theory of luminosity, by V. B. Lewes. The adverse criticism of the acetylene theory of luminosity by Smithells does not affect the considerations upon which the theory is based; these are (1) that the unsaturated hydrocarbons in the inner region of the flame are largely converted into acetylene before luminosity commences; (2) that pure acetylene develops luminosity when flowing through a heated tube; (3) that the temperature necessary to decompose acetylene with evolution of light does not raise to incandescence the liberated carbon; and (4) that in luminous hydrocarbon flames of sufficiently high temperature, the luminosity varies directly with the amount of acetylene present at the point where luminosity commences.—The action of sodium alcoholate on certain aromatic amides, by J. B. Cohen and W. H. Archdeacon. Many of the aromatic amides form addition compounds with sodium methor eth-oxide; thus, acetanilide yields a substance of the composition PhNHAc, MeONa.—Note on the electrical conductivity of formanilide and thioformanilide, by T. Ewan.—The action of sugar on ammoniacal silver nitrate, by J. Henderson. A definite factor can be assigned expressing the action of glucose, lævulose, and galactose on ammoniacal silver nitrate under standard conditions, but no such factor can be obtained in the case of lactose or maltose, owing to secondary reactions. Canesugar, starch, and dextrin do not act on the ammoniacal solution under the standard conditions.—Solution and diffusion of certain metals in mercury, by W. J. Humphreys.—On some of the ethereal salts of active and inactive monobenzoyl, dibenzoyl, diphenylacetyl, and dipropionyl glyceric acids, by P. Frankland and J. MacGregor. The physical properties of these salts have been determined. and the relation between the rotatory power and the constitution of glyceric acid derivatives is discussed.—On the rotation of optically active compounds in organic solvents, by P. Frankland and R. H. Pickard. As a result of cryoscopic and rotatory power determinations of methyl dibenzoylglycerate and ethyl diacetylglycerate in various solvents, the authors find that when the substance has a low molecular weight, the specific rotation is high, and *vice versâ*; the bearings of these results are discussed.—Note on the action of hydrogen chloride on ethyl alcohol, by J. C. Cain.—Transformation of the alkylammonium cyanates into the corresponding ureas, by J. Walker and J. R. Appleyard. Measurements of the rates of transformation of the alkylammonium cyanates into ureas, and *vice versâ*, indicate that the cyanates are dissociated into two ions in aqueous solution. On certain phenylthiocarbamates, by H. L. Snape.—The available potash in soils, by T. B. Wood.

Linnean Society, January 16.—Mr. C. B. Clarke, F.R.S., President, in the chair.—Messrs. O. V. Aplin and William Cole were elected Fellows of the Society.—On behalf of Mr. G. H. Adcock, of Geelong, Victoria, Mr. A. B. Rendle exhibited and made remarks upon some photographs of *Hakea grammatophylla*, F. Muell, a little-known species of the Proteaceæ, of local distribution in South Australia.—Mr. G. F. Scott Elliot exhibited specimens of bark cloth from Uganda and the shores of Lake Tanganika, and gave an account of the mode of its preparation from the bark cloth fig, and of the fleshy Euphorbias and Acacias of British East Africa, illustrating his remarks with lantern slides from photographs taken by himself. Mr. Elliot remarked that the native cloth manufactured on the shores of the Tanganika was made on the same sort of rough loom which he had seen employed near Sierra Leone, and that as the Tanganika is ethnologically and botanically part of the west coast, it was interesting to find that the methods employed in countries so far apart were so similar in detail. A discussion followed, in which Messrs. Rendle, Holmes, T. Christy, and W. Carruthers took part.—On behalf of Mr. W. R. Ogilvie Grant, Mr. Harting exhibited some land shells and eggs and skins of two rare Petrels from the Salvage Islands, lying between the Canaries and Madeira. These islands were stated to be of volcanic origin faced with steep rocks from 100 feet to 300 feet in height, and covered with loose sandy soil, the vegetation consisting chiefly of the wild tomato *Lycopersicum esculentum*, the ice-plant *Mesembryanthemum crystallinum*, *Asparagus scoparius*, and *Cistanche lutea*. Amongst the shells collected were *Helix ustulata*, peculiar to the Salvage Islands, *H. pisana*, *H. Macandrewi*, *H. polymorpha*, *Rumina decollata*, *Littorina striata*, *Cerithium rupestre*, and *Nassa conspersa*. *Helix paupercula* was said to furnish the chief food of the Tarantula spider (*Lycosa maderiana*), and entire shells of *Helix pisana* had been found in the stomach of a Kestrel hawk shot on one of the islands. The Petrels exhibited with their eggs were *Pelagodroma marina*, and *Oceanodroma cryptoleucura*, which were found nesting in burrows after the manner of the Shearwater (*Puffinus kuhli*), of which great numbers were also breeding there. Mr. Howard Saunders offered some critical remarks on these birds, referring chiefly to what was known of their geographical distribution.—Mr. George Murray exhibited full-grown complete specimens of some giant Laminarians from the Pacific, *Nereocystis*, *Egregia*, and *Macrocystis*, and some very fine specimens of *Postelsia*, collected by Mr. W. E. Shaw on the coast of California. He made some remarks on the distribution of Californian *Laminarieæ*, and illustrated some points in the structure of their reproductive organs.—A paper was then read, by Prof. T. Rupert Jones, F.R.S., and Mr. Frederick Chapman, on the relations of the fistulose *Polymorphianæ* and the *Ramulinæ*, with the view of showing the existing evidence for or against the suggestion that several specimens referred to the latter of these two sub-families may really belong to the former.

Geological Society, January 22.—Dr. Henry Woodward, F.R.S., President, in the chair.—Mr. W. W. Watts, in the absence of Prof. Lapworth, called attention to three specimens of sandstone and limestone containing specimens of some species of *Hyolithes*, which Prof. Lapworth had found in the higher part of the Cambrian quartzite at Nuneaton in Warwickshire.—The following communications were read:—On the Speeton series in Yorkshire and Lincolnshire, by G. W. Lamplugh. Further work on the Speeton section, while extending the knowledge of the palæontological details, had fully sustained the results of the author's previous investigations. The rapid attenuation and final disappearance of the Speeton series in a westerly direction in Yorkshire was discussed, and though the available evidence was held to be insufficient to demonstrate the exact conditions, it was stated that, contrary to the accepted view, the lower zones were probably the first to die out and were overstepped or overlapped by the higher divisions, since at Knapton, fourteen miles inland, only the upper zones of the coast-section can be proved to occur. In Mid-Lincolnshire all the palæontological zones of Speeton were identified and traced, the presence of the leading zonal types of the cephalopoda readily establishing the general correlation proposed by Prof. A. Pavlow and the author. The President said that it was hardly possible when mapping in the field to do more than follow those petrological changes in the character of beds over any given area which are patent to the observer. The point discussed by the author was that the life-line did not follow the line of the same sedimentation, but life-forms may transgress, and did transgress, over sediments of different character when they happened to be accumulated at the same time. It was hoped, however, that the case propounded by the author was exceptional, and that, as a rule, the sediments and the fossils followed one another on the same lines.—On some Podophthalmous Crustaceans from the Cretaceous formation of Vancouver and Queen Charlotte Islands, by Dr. Henry Woodward, F.R.S.—On a fossil octopus, *Calais Newboldi* (J. de C. Sby., MS.), from the Cretaceous of the Lebanon, by Dr. Henry Woodward, F.R.S.—On transported boulder clay, by the Rev. Edwin Hill. The "mid-Glacial" sands of the cliffs between Yarmouth and Lowestoft are overlain at Corton by chalky boulder clay. But farther north than Corton some masses of the same clay occur in the interior of the cliffs, surrounded by the sands in undisturbed stratification, but passing into them by strings and patches such as suggest the melting off of enveloping ice. They had probably been floated and dropped there. The observations suggest that chalky boulder clay was being manufactured in one locality simultaneously with "mid-Glacial" sands in another.

Mineralogical Society, February 4.—W. W. Watts in the chair.—Mr. L. J. Spencer gave an account of some of the results he had obtained in the course of an examination of various massive and fibrous forms of calcite and aragonite.—Mr. F. Rutley read a paper relative to associated globular and rhombohedral forms of rhodochrosite and chalybite from Cornwall.—Mr. G. T. Prior described the microscopic characters of certain rocks, allied to Monchiquite, collected by Mr. Ridley in Fernando Noronha, Brazil.—Mr. W. J. Pope explained a method of determining the optic axial angle for the case where the faces of the investigated plate are oblique to a bisectrix, and demonstrated the phosphorescence of saccharin crystals on fracture.

Zoological Society, February 4.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—Mr. G. A. Boulenger, F.R.S., read a report on the second portion of the reptiles and batrachians collected by Dr. A. Donaldson Smith during his recent expedition to Lake Rudolph, the first portion having been already described. In the present report forty-two species of reptiles and five of batrachians were catalogued—of which two lizards were described as new, under the names *Agama smithi* and *A. lionotus*.—Dr. A. Günther read a report on the collection of fishes made by Dr. Donaldson Smith during his expedition to Lake Rudolph. From Lakes Rudolph and Stephanie examples of eight species of fishes had been obtained. Of these, five were species also found in the Nile-basin, and mostly of wide distribution in Africa; while one (*Distichodus rudolphi*) was new to science. Two other species were also described as new, and named *Clarias smithi* and *Synodontis smithi*, after their discover.—Mr. Martin Jacoby offered some remarks on the system of coloration and punctuation in the beetles of the genus *Calligrapha* of the family Chrysomelidæ.—Mr. F. E. Beddard, F.R.S., read a paper on the oblique septa in Passerine and other birds, in which he pointed out a new character of Passerine birds.—A second paper, by Mr. Beddard, contained a note upon the syrinx and the ambiens muscle of an African stork (*Dissura episcopus*), and comprised some remarks upon the classification of the Herodiones.—A communication from Mr. R. Lydekker, F.R.S., contained a note on the mode of progression of the sea-otter.—A communication from Dr. St. George Mivart, F.R.S., contained a description of the hyoid bones of *Nestor meridionalis* and *Nanodes discolor*.

PARIS.

Academy of Sciences, February 3.—M. A. Cornu in the chair.—Notice was received from the Minister of Public Instruction of the approval, by the President of the Republic, of the election of M. Rouché.—On the equilibrium of an ellipsoidal envelope, by M. L. Lecornu. The problem of a flexible inextensible surface submitted to a given system of forces gives rise to a system of partial linear equations, the integration of which, in general, is not possible. The particular case, however, of an ellipsoidal membrane, which is of considerable practical value on account of its application to the theory of aerostats, can be dealt with by the use of elliptical coordinates, and the results of the integration are given.—The measurement of a section of the Paris base line, with the apparatus of Jäderin, by M. d'Abbadie. By the use of wires of steel and of bronze, of known coefficients

of expansion, a base line can be measured at the rate of 2500 metres *per diem*, as against 400 metres when bars are used as the standards of length.—Solar observations made at the observatory of the Roman College during the second half of 1895, by M. P. Tacchini.—On the complete solutions of the equation

$$x_1 \tan^{-1}\frac{1}{\kappa_1} + x_2 \tan^{-1}\frac{1}{\kappa_2} + \ldots + x_n \tan^{-1}\frac{1}{\kappa_n} = k \cdot \frac{\pi}{4},$$

by M. C. Störmer. A continuation of a note presented to the preceding meeting of the Academy.—On the energy dissipated in magnetisation, by M. Maurain. An attempt to measure the energy dissipated by iron and steel wires in a closed magnetic cycle when the variations in the strength of the field are very rapid (see p. 350).—Resistance of thin metallic sheets, by M. Ed. Branly.—Observations on a recent note, by M. G. Le Bon, on the "dark light," by M. G. H. Niewenglowski. A repetition of M. Le Bon's experiment, carried out in complete darkness, still gave a similar result, showing that the image is due to stored-up luminous energy.—Photography with dark light, by M. Gustave Le Bon. In further experiments made on this subject especial care has been taken to eliminate the possible influence of heat, and of light stored up in the plates.—New properties of the X-rays, by MM. L. Benoist and D. Hurmuzescu. The X-rays discharge a gold-leaf electroscope, and this offers a ready method for examining the permeability of various substances to these rays.—Experiments on the Röntgen rays, by M. A. Nodon. These rays are clearly distinguishable from the ultra-violet rays by the fect that the latter, obtained from a powerful arc lamp, fail entirely to affect a sensitive plate protected with several thicknesses of blackened paper. The Röntgen rays readily affect the plate under these conditions.—Transparency of metals for the X-rays, note by M. V. Chabaud. In sheets of 0·2 mm. thickness, platinum and mercury alone are perfectly opaque, while lead, zinc, copper, tin, steel, gold, silver, and aluminium are more or less transparent. In sheets of ·01 mm. thickness, platinum also ceases to be perfectly opaque.—The photography of metallic objects through opaque bodies, by means of the brush of an induction coil, without a Crookes' tube, by M. G. Moreau.—On the acid fluorides, by MM. Meslans and F. Girardet. The method employed is to act on the corresponding chloride with the fluoride of either arsenic, antimony, silver, or zinc. The fluorides of propionyl and of benzoyl were prepared and their properties examined.—Method of preparation of acid fluorides, by M. A. Colson. The acid anhydrides, treated with hydrofluoric acid, give the corresponding acid fluoride and acid. The chlorides of acetyl and propionyl are very easily obtained in this way.—On a hydride of lithium, by M. Guntz. Lithium, at a low red heat, absorbs about seventeen times its volume of hydrogen without any change of appearance; at about a red heat further absorption commences, and on cooling the lithium is seen to be covered with a layer of hydride. This was prepared in a pure state, and proved to be LiH.—The negative reaction and the centre of the retina, by M. Aug. Charpentier.—Researches on the embryonic nervous system of the Nauplius and of some larvæ of marine animals, by M. N. de Zograf.—On an Ophidian of the cretaceous earths of Portugal, by M. H. E. Sauvage.—Physiological researches on the respiration of fishes (*Ammodytes tobianus*), by M. J. B. Pieri. This fish was able to completely extract the oxygen from a solution of air in water, although it could not take out all the oxygen from a solution rich in the gas. Asphyxia is never instantaneous, even when the *Ammodytes* is introduced into water completely freed from dissolved oxygen. This fish can exist without inconvenience in water containing a considerable quantity of dissolved carbon dioxide.—Observations on the cephalic vesicle of insects of the family Muscides, by M. A. Laboulbène.—*Mucor* and *Trichoderma*, by M. Paul Vuillemin. Some remarks on a paper of M. J. Ray on the parasitism of a *Trichoderma* on a supposed new species of *Mucor*.—On the geological characters of the auriferous conglomerates of the Transvaal, by M. L. de Launay.—On the bed of eruptive and metamorphic rocks of the basin of Lavol, by M. D. P. Œhlert.—Petrographic study of the Albitophyres of the Laval basin, by M. Michel Lévy.—The effects of the solar displacements, considered by themselves, on the barometric pressures of the zone 10° to 30° N., by M. A. Poincaré.—On a meteor seen at Baleine on January 6, 1896, by M. Doumet-Adanson. This meteor, the appearance of which was noted to the Academy on January 13, was seen at Baleine at 5.7 p.m. (Paris time), passing horizontally, about 25° above the horizon.

BERLIN.

Meteorological Society, January 7.—Prof. Börnstein, President, in the chair.—Prof. Kremser spoke on the duration of sunshine over Europe, basing his remarks on the data available from the various stations. The mean duration increases from the north towards the south, being least in Scotland and greatest in Spain. There is also a distinct increase from the west eastwards. It is less on mountains than over open plains, except at very high stations which are frequently above the level of the clouds and mist. All stations show a yearly minimum in the winter solstice, and a maximum in the summer; the latter occurs as early as May in Scotland, in June over Germany, and in July over Spain. There is no such annual variation observable at the highest stations. The amplitude of the annual curve is less when based on the percentage of observed to possible duration of sunshine. The curve of daily variation rises sharply in the morning, is then steady for some time, and falls again sharply towards the evening. At high stations the daily maximum occurs in the afternoon.

AMSTERDAM.

Royal Academy of Sciences, November 30, 1895.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Engelmann treated the following subjects. (1) The influence of the pulse frequency upon the physiological conductive power of the ventricular muscle. (2) A means of rendering extra-polar electric impressions upon muscles and nerves impossible.—Prof. Lorentz read a paper on Poynting's theorem concerning the transfer of energy in the electromagnetic field, and on two general propositions in the theory of light. After showing how Poynting's theorem may serve to calculate the energy of a magnetised body and the development of heat due to magnetic hysteresis, the author discussed a more general formula, already used by Volterra. The application of this equation to the propagation light (homogeneous and of constant intensity) leads in the first place to a well-known law of reciprocity (viz. a relation between the vibrations at a point A, caused by a source of light at B, and the vibrations at B, produced by a source at A) and in the second place to a generalisation of "Huygens' principle." If, in a system of conducting or dielectric, isotropic, or anisotropic bodies, surrounded on all sides by the ether, a closed surface be arbitrarily chosen, so, however, that all sources of light are external to it, then a definitive distribution of sources of light over this surface may be indicated, which would give rise at all internal points to the same vibrations as are produced by the external sources.—Prof. Kamerlingh Onnes communicated Dr. Zeeman's further measurements on the absorption of electrical waves in different electrolytes. The results are: (1) the intensity of electrical vibrations (wave-length 6·5 m.) decreases to one-third of its original value when the vibrations pass a layer of a solution of sulphate of copper, 5 per cent. c.m. in thickness, the resistance being $3340 \cdot 10^{-10}$ that of mercury. (2) Different aqueous solutions of the same conductivity absorb vibrations of the same frequency in the same degree.—Dr. W. van Bemmelen has drawn the lines of equal secular variation of the magnetic declination for the period 1540–1880. The values of the yearly variations have been determined by measuring the inclination of the curves on his map, which shows the curves of the secular variation for 8 x 18 intersections of meridians and parallels (meeting of September 28).—The maps for 1780 and 1880 show that Bauer's isoclinal poles lie in the immediate vicinity of the lines of maximum variation; whilst the whole system of maps points out the fact that in the tropical zone these lines and the agonic lines accompany each other. The mean yearly rates of shifting of the poles, the agonic lines and the maximum lines, viz. 0°·194, 0°·184 and 0°·21, agree very closely.

December 28, 1895.—Prof. van de Sande Bakhuyzen in the chair.—Prof. W. Kapteyn gave a new treatment of a problem on *Analysis situs*.

GÖTTINGEN.

Royal Society of Sciences.—The third part of the *Nachrichten* (physico-mathematical series) for 1895 contains the following papers communicated to the Society:—

May 25.—On the development of *Dadocrinus gracilis* (von Buch) and *Holocrinus Wagneri* (Ben.), and their relation to other crinoids, by A. von Koenen.

June 15.—On the integration of the partial differential equation $\Delta u + k^2 u = 0$ on Riemann's surfaces, by A. Sommerfeld.—The hypsographic curve of the earth's crust and the relations of Romieux ,by Hermann Wagner.

July 6.—On certain regularities in the spectra of solid bodies, and on a new determination of the sun's temperature, by F. Paschen.

July 20.—Researches (ii.) from the Göttingen University Laboratory: (1) On new instances of isomerism and abnormal molecular refraction in certain cyclic ketones; (2) on pulegon, by O. Wallach.—Report on the scientific memoirs issued from the Göttingen University Pathological Institute in the session 1894–95, by J. Orth.

October 19.—(1) Contributions to the theory of algebraic numbers; (2) the unimodular substitutions in an algebraic *Zahlenkörper*, by A. Hurwitz.—On a geometrical representation of the ordinary development of a continued fraction, by F. Klein.—On the regions of discontinuity of the groups of real linear substitutions of a complex variable, by Robert Fricke.—On the foundations of the theory of "ideals," by Ph. Furtwängler.

November 2 (Commemoration-day).—On the "arithmetisation" of mathematics, by F. Klein.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 4.30.—On the Behaviour of Argon and Helium when submitted to the Electric Discharge: Dr. J. N. Collie and Prof. Ramsay, F.R.S.—On the Generation of Longitudinal Waves in Ether: Lord Kelvin, F.R.S.—On the Discharge of Electricity produced by the Röntgen Rays, and the Effects produced by these Rays on Dielectrics through which they pass: Prof. J. J. Thomson, F.R.S.

SOCIETY OF ARTS, at 4.30.—Punjab Irrigation—Ancient and Modern: Sir James Broadwood Lyall, G.C.I.E., K.C.S.I.

MATHEMATICAL SOCIETY, at 8.—Geodesics on Quadrics, not of Revolution: Prof. Forsyth, F.R.S.—Solid Ellipsoidal Vortex: R. Hargreaves.—Potential of a Cyclide: A. L. Dixon.

ROYAL INSTITUTION, at 3.—Some Aspects of Modern Botany: Prof. H. Marshall Ward, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electric Wiring Question: F. Bathurst.—Concentric Wiring: Sam. Mavor.

SOCIETY OF ANTIQUARIES, at 8.30.

GRESHAM COLLEGE (Basinghall Street, E.C.), at 6.—The Planet Jupiter: Rev. E. Ledger.

FRIDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 9.—Fish Culture: J. J. Armistead.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—On the Determination of High Temperatures with the Meldometer: W. Ramsay and N. Eumorfopnilos.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of the Molong to Forbes Railway, New South Wales: Sydney Thow.

MALACOLOGICAL SOCIETY, at 8.—Annual Meeting.

GRESHAM COLLEGE, at 6.—The Planet Jupiter: Rev. E. Ledger.

SUNDAY, FEBRUARY 16.

SUNDAY LECTURE SOCIETY, at 4.—Water Skin: Douglas Carnegie.

MONDAY, FEBRUARY 17.

SOCIETY OF ARTS, at 8.—The Chemistry of certain Metals and their Compounds used in Buildings, and the Changes produced in them by Air, Moisture, and Noxious Gases, &c.: Prof. J. M. Thompson.

VICTORIA INSTITUTE, at 4.30.—China: Dr. Gordon.

TUESDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 3.—External Covering of Plants and Animals: Prof. C. Stewart.

SOCIETY OF ARTS, at 8.—The Development of Electrical Traction Apparatus; H. F. Parshall.

ZOOLOGICAL SOCIETY, at 8.—On the Butterflies obtained in Arabia and Somaliland by Captain Chas. G. Nurse and Colonel J. W. Yerbury in 1894–95: Dr. Arthur G. Butler.—On Moths collected at Aden and in Somaliland: Lord Walsingham, F.R.S., and G. F. Hampson.—Observations on the Metallic Colours of the Trochilidæ and the Nectariniidæ (communicated by F. E. Beddard, F.R.S.): Miss Marion Newbigin.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Manufacture of Aluminium by Electrolysis; and the Plant at Niagara for its Extraction: Alfred Ephraim Hunt.

ROYAL STATISTICAL SOCIETY, at 5.—Mental and Physical Conditions among 50,000 Children seen 1892–94, and the Methods of Studying Recorded Observations, with special reference to the Determination of the Causes of Mental Dulness and other Defects: Dr. Francis Warner.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.

PATHOLOGICAL SOCIETY, at 8.30.

ROYAL VICTORIA HALL, at 8.30.—Flowers and their Insect Visitors: Dr. Kimmins.

WEDNESDAY, FEBRUARY 19.

SOCIETY OF ARTS, at 8.—Report of the Royal Commission on Secondary Education: H. Macan.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1895: Edward Mawley, President.—Notes on the Recent unusually High Barometer Readings in the British Isles: Robert H. Scott, F.R.S.—Turner's Representations of Lightning: Richard Inwards.

ROYAL MICROSCOPICAL SOCIETY, at 8.

ENTOMOLOGICAL SOCIETY, at 8.—Notes on Flower-Haunting Diptera: G. F. Scott-Elliot.—On the Nomenclature of the Geometridæ: A. Radcliffe-Grote.

THURSDAY, FEBRUARY 20.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture—The Diffusion of Metals: Prof. Roberts-Austen, F.R.S.

ROYAL INSTITUTION, at 3.—Some Aspects of Modern Botany: Prof. Marshall Ward, F.R.S.

LINNEAN SOCIETY, at 8.—On Discoveries resulting from the Division of a Prothallus of a Variety of Scolopendrium vulgare: E. J. Lowe, F.R.S.

CHEMICAL SOCIETY, at 8.—Origin of Colour: the Yellow 2:3 Hydroxynaphthoic Acid; Note on Etherification; The Relation of Pinene to Citrene: Prof. Armstrong, F.R.S.

LONDON INSTITUTION, at 6.—My Voyage to Siberia: Captain Wiggins.

NUMISMATIC SOCIETY, at 7.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 21.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

ROYAL INSTITUTION, at 9.—The Past, Present, and Future Water Supply of London: Dr. E. Frankland, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—Light: Lord Rayleigh, F.R.S.

ROYAL BOTANIC SOCIETY, at 3.45.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Cocoa, all about it: "Historicus" (Low).—Links in a Long Chain: Mrs. A. Bell (Philip).—Annuaire de l'Observatoire Municipal de Montsouris, 1896 (Paris, Gauthier-Villars).—Cours de Physique de l'École Polytechnique: Prof. M. Bouty, premier supplément (Paris, Gauthier-Villars).

PAMPHLETS.—Atlas des Isanomales et des Variations Séculaires du Magnétisme Terrestre: Lieut.-Géneral A. de Tillo (St. Pétersbourg).—Royal Gardens, Kew: Hand-List of Orchids cultivated in the Royal Gardens (Eyre).

SERIALS.—Scribner's Magazine, February (Low).—Transactions of the English Arboricultural Society. Vol. 3, Part 1 (Carlisle).—Geological Magazine, February (Dulau).—Engineering Magazine, February (Tucker).—Massachusetts Institute of Technology, Boston, Annual Catalogue, 1895–96 (Cambridge, Mass.).—American Journal of Science, February (New Haven).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, Tome 30, No. xii. (Bruxelles).—Proceedings of the Royal Society, Edinburgh, Session 1894–95, Vol. xx. pp. 481–546 (Edinburgh).—Bulletin of the American Mathematical Society, January (New York, Macmillan).

CONTENTS.

THURSDAY, FEBRUARY 20, 1896.

EMBRYOLOGY.

Text-book of the Embryology of Invertebrates. By Dr. E. Korschelt and Dr. K. Heider. Part I. Translated from the German by Edward L. Mark and W. McM. Woodworth. Pp. xvi + 484. (London: Swan Sonnenschein and Co., 1895.)

EMBRYOLOGY "is one of the most important subjects in the whole round of Natural History." So says Darwin, and so say all zoologists who have the knowledge to appreciate, and the training and patience to deal with, the innumerable facts which constitute that most fascinating branch of their subject.

Formerly the view was held—it is even now held by some zoologists—that embryology is a subject apart from the other branches of zoology; that a man might be a complete zoologist without any knowledge of it; that it could throw but little light upon those great questions of structure which it is the ambition of comparative anatomy to solve; and that it was a study which, if it did not actually narrow the mind, took it away from that pure and sympathetic contemplation of nature, which it was the object of all true zoological teaching to call forth. To such zoologists embryology was of but small importance.

And the reason for this attitude is not far to seek. In the good old days the equipment required by the zoologist was but slight, and the facts lay bare for every one to note. A collecting-box and a bottle of spirits, a pocket-lens and, by the more advanced, a pair of forceps and a scalpel were all that were required. With such simple instruments, combined with a certain power of observation and a love for nature, which had often more of an æsthetic than a scientific character, a man might go far. But this delightful time is past—the unaided pocket-lens is now of little service, the forceps and scalpel have revealed almost all that they are capable of revealing, and the bottle of spirits requires to be supplemented by a whole complement of elaborate reagents. And if this is true of the material requisites, how much more true is it of the intellectual. In addition to the elaborate technique, the complicated instruments and the whole routine of the modern laboratory, there are the immense accumulations of knowledge which must be mastered if nature is to be questioned with any hope of success. It is this training which is often irksome; it is these instruments which cannot be used without patience and practice; which bewildered the older zoologists, and which make the way so hard for those younger men who, with a collector's or an æsthetic's love for nature, wish to pose before the world, after the manner of their fathers, as experts in an important branch of science.

But to return to our question: What is the relation of embryology to the other branches of zoology? Clearly it is an integral part of the well-known and respected science of comparative anatomy; it is the part of that science which deals with the anatomy of the organism before the attainment of sexual maturity, and, inasmuch as most animals pass through several stages of structure during their growth, the study of it is, to the scientific anatomist at least, as important as the study of the adult. One would have thought that this position would have been conceded on all hands, and that there would have been no necessity to call attention to it here. But it is not so; for there are anatomists who hold that, in solving anatomical problems, the structure of the embryo is of very small importance indeed as compared with the structure of the adult.

But embryology is more than this. It has caused the use of methods and instruments which have extended the bounds of comparative anatomy; it has brought into the field men who, in their love of nature, in their capacity for patient labour, and in their powers of accurate observation, are at least the equals of the older naturalists; and it has brought to light facts of natural history which, but for it, would have remained in darkness, and which even that zoological butterfly, the amateur naturalist, would not pass by. To mention only a few such. What more wonderful phenomena can be mentioned in the whole round of natural history than the larval development and metamorphosis of the Echinodermata; the detachment and digestion of the brain and sense organs of the larva of Phoronis on the attainment of sessile life; the growth of the worm within the larval skin of the Pilidium; the double sexual life of the Ctenophora.

Of the relation of embryology to the evolution theory, we can only shortly refer. Apart from the construction of phylogenetic histories, to which unfortunately there appears to be no end, our science is of supreme importance as affording the most unanswerable, indirect corroboration of that theory which it is possible to obtain.

But embryology has wider bearings even than these. The systematist is powerless without it. He may ignore it, he may neglect it; but if he do so, he can have no true insight into the relations of the great groups. Until embryology was a science, the Tunicata were grouped near the Mollusca; and without its aid the great Cuvier himself was led into the error of placing the Cirrepedia in the same phylum. Nor can the student of species avoid his fate. To-day he may rejoice that he at least can pass by on the other side, and leave embryology to the embryologists. But, alas! it will not be so for long; even now embryonic characters are beginning to assert their claims for recognition, and in the near future a knowledge of development will be as indispensable to the species-monger as to any other kind of zoologist.

It would thus appear that embryology has a classificatory as well as an anatomical value, and should be dealt with in works on zoology. But while in works on anatomy it is quite impossible to ignore the facts of development, it is unfortunately true that in zoological treatises, systematic embryology is either entirely neglected or else treated in such a sketchy way as to be useless, or nearly so, to the student. But in saying this, we desire to impute no blame to zoological authors, who are already overburdened with the immense mass of facts which they have to treat. Hence the necessity for books specially dealing with the subject—books which had their model and initiator in the great work on comparative embryology by F. M. Balfour. The book before us may, indeed, almost be regarded as a second edition of that work, so closely are Balfour's plan and

method followed. And surely no greater praise could be given to it. Not only is the method of treatment almost identical, but the points of view from which the facts are looked at is almost exactly the same as that adopted by Balfour more than fifteen years ago. The passage—"In the group Metazoa or germ-layer animals, on the contrary, there always results a multicellular organism (cell-community or cell-corm), in which the single cells give up their independence for the good of the community, and accommodate themselves to a division of labour, in consequence of which there is brought about a diversity in the structure and function of the cells of the Metazoan organism" (Introduction, p. 1)—shows that the cell-theory in its modern form is the key-note of the work, and that the germ-layer hypothesis of Huxley and Kowalevsky still holds the prominent position assigned to it in Balfour's work. And we are very far from blaming the authors for thus adhering to the old faiths of the seventies; for though much may now be urged to diminish the importance of these hypotheses, which in their day have done yeoman's service to the furtherance of anatomical science, and though it might be argued, as has lately been done in more than one quarter, that they are moribund and powerless to lead us further in the intricate task of unravelling structure, still it would be foolish, to say the least of it, to cast them on one side in a didactic work of this kind, until some better, some more penetrating guide has been found to replace them.

After this, it is hardly necessary to say that it is our opinion that the authors are men of sound judgment, a fact which is shown in every chapter of their work. But we have said enough to indicate our admiration for the work. The authors are scholars in the best sense of the word. Their erudition is profound, their accuracy is minute, their industry and patience must be marvellous, and their critical powers are quite first-rate. In soundness and impartiality their judgment leaves nothing to be desired. So far as our knowledge goes, credit is always well apportioned, and conflicting statements are handled, if not with the consummate skill of Balfour, still in a manner which is unusual in works of the kind.

The volume before us is part i. of the German work, and deals with the Porifera, Cœlenterata, Platyhelminthes, Nematelminthes, Annelida, Echinodermata, Rotifera, Chætognatha and Enteropneusta, treated entirely in a systematic manner.

Parts ii. and iii., of which a translation is promised, complete the treatment of the invertebrata. In the authors' preface, a general part is spoken of, but so far as we know it has not yet appeared; and the vertebrata are expressly excluded from the scope of the work. This omission we hold to be a defect. The authors defend it on the ground that that department of the subject has been adequately treated recently by other hands. We entirely differ from this view; for not only do we hold that no entirely satisfactory treatment of the vertebrata has appeared since Balfour's work, but that no satisfactory treatment is possible apart from the rest of the animal kingdom. Moreover, though the phylum vertebrata is only one phylum of the animal kingdom, no scientific treatment of the subject as a whole is possible without at least a consideration of the facts of vertebrate embryology. One might as well, in a scientific treatise on chemistry, omit all reference to carbon and its compounds. We sincerely hope that the authors will change their minds, and will, when they issue the general part, append an account of vertebrate embryology.

In a work of this magnitude there must be a certain number of small mistakes and slips; but we have found surprisingly few of them. We might, however, call attention to two, which bear on subjects having a certain amount of general interest. On p. 3, it is stated that the "ectoderm germ-layer presides over the animal functions (sense, perception, locomotion)." This is of course an error; for not only are the most important muscles often endodermal in origin, but, if certain observations are to be trusted, it is highly probable that the main nervous tracts arise *in situ* in the mesoderm. On p. 31, a series of diagrams showing the structure of the canal-system in certain sponges is described as "a diagram of the development of the canal system in various sponges." This is obviously a loose statement. What the authors probably mean is, that the diagrams illustrate various conditions of the canal-system, which are actually met with in different sponges, and which may be supposed hypothetically to represent permanently stages of structure through which the more complicated canal systems have passed in phylogeny. This slip is of more importance than at first sight it may appear to be, because phylogenetic speculations, if they are to have any value at all, and not to be mere hindrances, must be described in the most precise language, and based upon the most exact ideas. It is very important at the present time, when so many loosely-conceived and worthless phylogenetic hypotheses are constantly being put forward, that the necessity for precision and clearness of thought at least should be regarded as indispensable in all attempts to trace the ancestry of living animals.

With this one exception, which is obviously a slip, this volume is happily entirely free from all blemishes of the kind. The phrase, "embryonic connective tissue," though no doubt sanctioned by usage, is one to which we take exception. The tissue so described has almost, if not quite always, nothing whatever in common with connective tissues as ordinarily conceived, but is a germinal or growing tissue which gives rise to most important organs.

The translators have performed their task with skill. There are short notices, made for the most part by the authors, of the more important memoirs which have appeared since the publication of the original in 1890. The German idiom is quite got rid of, and the book in its English form is eminently lucid and readable. The translators are to be congratulated on their work, and have earned the gratitude of all English zoologists. But, alas! there is one serious blemish. If the translators were Englishmen, we should call it an error of taste; but being Americans, we must make allowances, and put it down as another example of the curious incompleteness of their knowledge of the English language, which some Americans are known now and again to display. We all know how frequently the word *anlage* is used in German works on embryology; and we all know that some authors, notably those writing in America, refusing to use the English equivalent, have attempted to add this word to the English language. The translators of this work have

not taken this course—we almost wish they had—they have decided to use an English equivalent. But instead of using the English word *rudiment*, a well-known word, a respectable word, one might almost say a classic word in the ears of English zoologists—a word which well covers the meaning of the German word "anlage," and the use of which in this sense can be productive of no confusion, they have invented a new rendering; and—O ye gods!—what a rendering!

We would pardon the ignorance of one who did not know that the first and most common meaning of the word *rudiment* is the "original of anything in its imperfect form." But the editors have not stopped short at this: they have fallen from Scylla into Charybdis; they have employed a word with the meaning of which every schoolboy is familiar—often painfully familiar—a word which has only one usage in English, and that a usage which, to all people with a sense of humour, would entirely unfit it for the present purpose, even if it were required. They have displayed an ignorance which is almost incredible in men who speak the English language, an ignorance which, while it may help us to understand certain peculiarities observable in some of their countrymen, is fraught with the most ludicrous results in the present instance. We sincerely regret that we are obliged to call attention to this blemish. It is hard upon the authors to have their work served up to the English public with such a grotesque ingredient. We feel that the publishers, who at any rate are Englishmen, should have seen to the matter, and we sincerely hope that the pages of parts ii. and iii. of this most valuable work will not be defaced by such a misuse of a well-known and old-established English word.

It only remains to say that the book is well got up. The printing is good, the illustrations are excellent, and the size is convenient.

THE EVOLUTION OF CULTIVATED PLANTS.

Plant-Breeding: being Five Lectures upon the Amelioration of Domestic Plants. By L. H. Bailey. Pp. 293. Figs. 20. (New York and London: Macmillan and Co., 1895.)

WHEN, in 1859, Darwin's "Origin of Species" first saw the light, naturalists were astonished at the large number and variety of illustrations the author derived from cultivated plants. This feeling was accentuated in 1868, when the "Variation of Animals and Plants under Domestication" appeared. Previous to that time botanists had, for the most part, ignored the productions of the horticulturists, or looked upon them as so many sources of annoyance and confusion. With the publications just mentioned, there dawned upon the minds of thinkers the notion that what was done in nature slowly and gradually had been, and was effected by the gardener rapidly and, relatively, with equal certainty.

Variation, selection, adaptation, progressive evolution were seen to constitute the basis of the work of the gardener and the "florist" in their attempts to gain new and improved varieties. Cross-breeding and hybridisation had been practised for generations. The first artificially-produced hybrid on record was raised in the beginning of the eighteenth century by Fairchild—a gardener. It was a hybrid Pink. After him came Bradley, Logan, Philip Miller, who each and all carried on their experiments on evolutionary lines. With Thomas Andrew Knight and Dean Herbert, we are brought down to modern times. They were great gardeners. Assuredly they were great evolutionists. And the work is going on day by day with more activity than ever. In addition to the constant improvement recognised in the case of agricultural and garden plants, the evidence of which may be seen in the seedsmen's trial-grounds and in the experimental garden of the Royal Horticultural Society at Chiswick, there is a positive production of new forms, so different from pre-existing ones, that were the history not known they might be thought to constitute new genera, or, at any rate, new sections. Take the tuberous Begonia, for instance. Thirty years ago or so, there was nothing like it either in nature or in gardens. Now, by the blending of various species, entirely new races have been produced; and these, to a large extent, are reproduced from seed. From the seedlings selection is made, and so the progress goes on. But some will say, Will they not die out if not looked after by the gardener? Of course they will; but are there no such things as retrogressions and extinctions in nature? The Begonias in question would doubtless die here if uncared for, as they are not suited to the climatal environment; but they would at least have a very good chance if removed to the Andean forests, whence their progenitors sprang.

The gardener, moreover, is often in a position to demonstrate the hybrid origin of some wild plants. There are now numerous cases in which certain wild orchids have been supposed, from the blending of morphological characters which they present, to have had a hybrid origin. Some botanists have hesitated to accept this kind of evidence, though we may say incidentally, that it has been borne out, in other genera, by Dr. Macfarlane's histological researches. More to the point is it to say that certain of these hybrid orchids have been actually artificially produced in Messrs. Veitch's nurseries by crossing the species that were reputed to be the parents of the supposed natural hybrids. The evidence is complete; and it alone is sufficient to show to the evolutionist what a vast and fertile field lies open to him in the observation, and especially in the experimental investigation of ordinary cultivated plants.

The reader will find numerous valuable hints and suggestions on the subject in Prof. Bailey's little book. It contains the substance of five lectures on variation and its causes, and on their application to the practical purposes of the cultivator. The most successful hybridisers and selectors act on a preconceived plan, according to their requirements; but since so much attention has been directed to the subject, there has been—indeed there always has been—much indiscriminate, haphazard experiment. Prof. Bailey cautions experimenters against such unscientific procedures, and supplies directions whereby the aim and purpose may more surely be attained.

The fourth lecture is largely a reprint from Carrière's paper on bud-variation, and from Focke's work on the hybridisation of plants; whilst the fifth contains practical instructions as to the methods of crossing employed by experimenters. A glossary and an index terminate a book which, if it contains little that is not familiar to experts, will be extremely serviceable to beginners, and will furnish the naturalist, who wishes to gain a general survey of the matter, with just the information he requires. For this latter purpose, a fuller bibliography would be an improvement in a new edition.

MAXWELL T. MASTERS.

OUR BOOK SHELF.

Die Haustiere und ihre Beziehungen zur Wirtschaft des Menschen. Eine geographische Studie von Eduard Hahn. Large 8vo, pp. 581, and a map. (Leipzig: Duncker and Humblot, 1896.)

THIS volume is an important contribution to our knowledge of the relations existing between domestic animals and human economy. It forms a large octavo volume of nearly 600 pages, compiled from all sources, and of its interest the reader may form some idea from the following summary of its contents. After a brief introduction, we have our domestic animals considered from a zoological standpoint; here the interesting questions of hybridisation and of the returning of once-domesticated animals to a feral state, are investigated. Next the subject of the profitableness of such animals is considered, the author alluding but casually to the fact that some animals were decidedly domesticated, without an eye to profit; he cites the case of some South American aborigines keeping a "grylla" in their houses for the perfume, but has apparently overlooked the case of the Greeks domesticating the cigale. He on purpose omits the subject of animals in connection with "worship," quoting Tylor, that "it is a subject not wanting in interest, but is one abounding in difficulties."

The list of domesticated animals (using this term in the widest sense of animals kept for the use or service of man) given is a long one, comprising not only such familiar forms as the dog, horse, ass, horned cattle, sheep, goats, reindeer, &c., but also the yak, gaur, llama, guinea-pigs, and ferrets. The list of birds is extensive; reptiles are not mentioned, save the axolotl in an appendix; and among the fishes we find the carp, the gold-fish, and the paradise-fish. Bees and several silk-spinners are mentioned among the insects.

The concluding portion of the work is devoted to economic geography, and is illustrated by a map, in which an attempt is made to mark out the world into areas characterised by aboriginal industries. Certain regions are coloured as being those of the hunters and fishers, then of the several divisions of mankind living upon tubers and cereals, or further advancing to the culture of such plants as sugar-cane, tobacco, and the like; still greater progress is indicated by the type of gardening as practised, for example, by the Chinese. Of the various regions of the world alluded to, that of Australia is the one most unsatisfactorily treated; there is scarcely an allusion to the wonderful culture of vegetables by the Maoris, for a very good knowledge of which we are long since indebted to the labours of Colenso and others. The subject treated of in this volume is of the widest range—in space covering the known world, in time going back to days of indistinct tradition, and for its complete investigation requiring some knowledge of an immense range of literature, this work is a contribution towards this history, and as such is a most useful one.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Velocity of Propagation of Electrostatic Force.

LORD KELVIN, in his letter published in NATURE, February 6, says that "it is an abuse of words to speak of the 'elastic solid theory of electricity and magnetism' when no one has hitherto shown how to find in an elastic solid anything analogous to the attraction between rubbed sealing-wax and a little fragment of paper . . . or between two wires conveying electric currents."

It has, no doubt, escaped Lord Kelvin's notice that in 1884 a paper was published in the *Cambridge Philosophical Transactions* (vol. xiv. p. 45), in which I showed that two spheres pulsating in an elastic medium will, if pulsating in opposite phases, attract each other as sealing-wax attracts paper, and if in the same phase will repel just as like electrified bodies do, the action being propagated in the medium with a finite velocity.

In a subsequent paper, published in 1885 (*Camb. Phil. Trans.*, vol. xiv. p. 188), I have shown that two straight oscillatory twists placed in an elastic medium will, if in the same phase, attract each other as like electric currents do, and if in opposite phases will be repelled. In fact, if the vibration of the surface of a solid placed in a vibrating elastic medium is resolved into normal and tangential vibrations, the normal vibrations will, as pointed out in these papers, cause the solid to exhibit several of the phenomena of statically electrified bodies, while the tangential vibrations will cause it to behave as if carrying a current and acted on by a magnetic field.

I only venture to mention these results because it appears from Lord Kelvin's letter that they are not generally known. They should, I believe, assist in forming a conception of a possible explanation of electric action, based on the supposition of an elastic medium which resists changes of volume and shape.

Firth College, Sheffield, February 11. A. H. LEAHY.

In making the statement quoted, I had fully taken into account all such considerations as those referred to in Prof. Leahy's letter. The rigidity of the solid absolutely prevents any phenomenon, analogous to the attractions by rubbed amber or lodestone, from being exhibited in an elastic solid. No such barrier exists if the elastic medium be fluid; and §§ 733-740 of article[1] xli. of my "Electrostatics and Magnetism" contain conclusions of hydrokinetic theory regarding mutual forces between movable tubes or rings with cyclic motion of an incompressible liquid through them, showing magnitudes identical with, *but directions exactly opposite to*, those of the forces in electro-magnetic analogues consisting of movable conductors conveying electric currents. The remainder of that article contains remarks on Guthrie's interesting paper[2] "On Approach caused by Vibration," and "On the Attractions and Repulsions due to Vibration, observed by Guthrie and Shellbach," from which the following (§ 744), being an extract from a report, in the *North British Daily Mail*, of an address by myself to the Philosophical Society of Glasgow on December 15, 1870, may possibly be read with interest in connection with Prof. Leahy's letter:—

"The speaker began by stating that interesting papers had recently appeared in the *Proceedings* of the Royal Society and the *Philosophical Magazine*, by Prof. Guthrie, in which some very curious hydrokinetic phenomena were described. From hints and suggestions in his paper, it seems that Prof. Guthrie connected, in his own mind, these phenomena with possibilities of explaining some of the more recondite actions in nature; and he (the speaker) believed that what gave the great charm to these investigations for Prof. Guthrie himself, and no doubt also for many of those who heard his expositions and saw his experiments, was, that the results belong to a class of phenomena to which we may hopefully look for discovering the mechanism of magnetic force, and possibly also the mechanism by which the forces of electricity and of gravity are transmitted. The speaker, however, did not lay any stress at present upon the possibility of applying these results directly to explain magnetism. He believed, on the contrary, that the true kinetic theory of mag-

[1] First published in the *Proc.* Roy. Soc. Edinb. for Feb. 1870.
[2] *Proc.* Roy. Soc., August 26, 1869.

netism (and the ultimate theory of magnetism is undoubtedly kinetic)[1] involves quite a different class of motions from those to which the beautiful phenomena discovered by Mr. Guthrie are due. He rather wished to point out the close connection that existed between the laws of some of these actions and the laws of magnetism, which, while involving some remarkable coincidences, involves certain contrasts decisive against any hypothesis, such as the ingenious one[2] of Euler, explaining magnetism by fluid motion directly comparable with that which forms the subject of the present communication." KELVIN.

The University, Glasgow, February 13.

The Stress in Magnetised Iron.

I AM glad to see from Dr. Taylor Jones' letter that he and Mr. Nagaoka contemplate a discussion of the *magnitude* of the magnetic stress really existing in iron under, I hope, natural conditions. A complete discussion of the sort would, I think, be of much value. It seems to me somewhat doubtful what is the true nature of the assumptions latent in Maxwell's work, vol. ii. arts. 630–646. I am uncertain whether his conclusions are strictly applicable to any case other than that of an infinite homogeneous medium in which the permeability is unity. In the ordinary case of a magnetic bar, some lines of force traverse the surrounding air, and complications also arise from the "free" magnetism at the ends. When, as in previous experiments on the magnitude of the stress, a magnetic bar or ellipsoid is cut in two, the stress measured is presumably that exerted across a minute air-film separating the opposed surfaces. Under such circumstances the formula $B^2/8\pi$ is, according to Dr. Taylor Jones' own experiments (*Phil. Mag.* for 1895, p. 254), a close approximation to the stress when the permeability of the bar is large.

Prof. Ewing's letter also calls for some comment at my hands. The view I advocated is hardly that he attributes to me. I expressed no opinion as to the correctness of the measure $B^2/8\pi$, assumed by Dr. More and others, for the *intensity* of the magnetic stress. Neither did I say the stress system reduced to a *simple* longitudinal tension. It is, I believe, in general considerably more complicated, and is accompanied by strain perpendicular to, as well as along the lines of force. Avoiding complications unessential to the point at issue, I simply supported the view that the magnetic stress along the lines of force is a tension, and that the associated strain in the metal along this direction is an extension.

Again, Prof. Ewing says that the case illustrated by me in p. 270 is a "special one." The illustration in question is, however, just as applicable to the case of an endless ring, to which he specially refers, as to that of a long rod. It is really based on three hypotheses or assumptions, as valid in one case as in the other: (1) that the magnetisation is uniform; (2) that the air gaps, real or imaginary, are narrow compared to the length of the element; (3) that the existence of an indefinitely thin air gap, such as may be found between two attracting pole faces in contact, does not affect the *sign* of the stress.

Now (1) is merely a definition, and (2) a mathematical expedient to simplify the proof, so that (3) alone remains. As regards (3), I merely followed Prof. Ewing in § 145 of his "Magnetic Induction," except in so far as I did not assume the existence of a narrow gap to be wholly immaterial. As Prof. Ewing admits that the stress in the case of my illustration is a *tension*, we should, if he adhered to his original views regarding (3), be now on the same side. He has, however, apparently completely altered his views, for he says: "Make the iron continuous by closing up the gaps, and the tensile stress disappears." This seems an explicit declaration that there is no such thing as a "Maxwell stress," and that consequently neither extension nor compression can be assigned to such a cause. Prof. Ewing's new view implies a sudden large discontinuity between the state of close juxtaposition of magnetic material, when the stress he admits is large, and that of absolute continuity, when the stress he says is nil.

It would, I think, be premature to do more than call attention to this apparent discontinuity until the arguments in favour of the new view are produced.

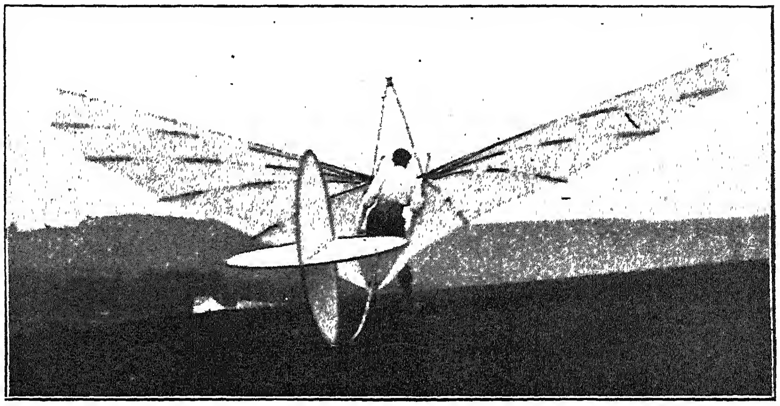
Prof. Ewing's remarks about the pulling and pushing of magnetised rings, indiarubber bands, &c., suggest that he experiences a difficulty in imagining any complete, homogeneous, isolated ring under conditions such that the normal stresses over all cross-sections are tensions. The consideration of the elastic stress system produced in an anchor ring by rotation about a perpendicular to the plane of its circular axis (line of centres of cross-sections) through the centre will be found, I think, to aid such a conception.

I must decline, I fear, to follow Prof. Ewing into the clothes-basket he refers to, though doubtless the experiment must be a fascinating one—for spectators. C. CHREE.

Kew Observatory, February 11.

Experiments with Soaring Machines.

AT the end of the article on Herr Lilienthal's soaring experiments, in your issue of January 30, reference is made to my trials, with somewhat similar apparatus, at Cardross, and it is said that so far I have not been very successful.



I do not consider this to be the case. I think that, so far as I have gone, my work has been rewarded with as much success as could possibly have been hoped for.

I only commenced to build my first machine just a year ago, and being very busy with other things, was not able to take the machine out to practise till June.

At first my wings were, as is stated, very much raised, so that the machine should have transverse stability of its own in flight, just as a kite is stable sideways when it is of this shape, or as a sheet of paper folded to a V-shape will always fall on the folded edge.

There is, however, a great practical difficulty with the raised wings, and that is, that if one stands not exactly head to wind, the machine tends to "pay off" from the wind, which then comes more on one side, and rolls the machine over.

With the wing tips lowered more as a gull's wings are, if the wind (virtual or real) is not ahead, through a squall or any other cause, the machine has very little tendency to raise on the windward side, and so be turned over by the wind.

Not appreciating this, certainly caused me some delay and breakages; but when I realised how great is the objection to the raised wings in such a squally place as Cardross, I curved the wings as shown in the second photo which I enclose, and with this original apparatus have been picked up by a puff of wind over and over again, sometimes as much as 12 feet above the spot I was lifted from, and put down again on exactly the same place. At other times, when there has not been so much wind, I ran to meet the wind with the front of the wings depressed somewhat, so that my weight is only partially taken by the wings, and in this way I am, strange as it may appear, able to run very

[1] "Electrostatics and Magnetism," § 290 (Roy. Inst. Friday Evening Lecture, May 18, 1860); "Electrostatics and Magnetism," § 546 (*Proc.* Roy. Soc., May 10, 1856).

[2] "Electrostatics and Magnetism," § 573.

much faster than without the wings; then raising the front edge a little, I am able to take a long soar down a slight incline. The only slopes on which I was able to practise, were not steep enough to make it possible for me to soar for any great distance; and therefore I have at times, on days when the wind was fairly steady, attached a string to the front of the machine, with which a boy has run and kept me in the air for about half a minute. I never used a line when there was enough wind to pick me up without forward movement, on account of the strong winds at Cardross being so very squally.

I had to stop experimenting at the end of September; but when I left off, I was pretty sure of my balance in the air, and was able to land without damage and without falling, even when soaring over the ground very fast. And this was the whole object of my work, so that I should be pretty sure of my balance before putting motive power into the machine to make horizontal flight possible. This I hope to do this year, with a petroleum engine, either working the screw propeller in the front of the machine, or two screws, one placed under each wing, so that the machine will then practically become a Maxim machine of the smallest size possible for one man to fly with.

Mr. Maxim has shown most clearly that his large machine at Bexley will rise on the underneath side of rails put down to prevent its rising further; and what is possible for this large machine, is just as possible for a small one. And I am confident that I could maintain horizontal flight with wings similar to those I have been using, or, better still, similar to those I am now making, which vary chiefly only in mechanical detail from the first, if driven forward as I propose.

Herr Lilienthal, who most kindly showed me his apparatus, and let me see him practise last April, has kept me informed of what he has been doing.

Mr. Lawrence Hargrave, of New South Wales, kindly wrote to me suggesting that I should use double surfaces, and advocated the construction he uses in his cellular kites, as being simple and light.

Although with the double surfaces now used by Herr Lilienthal a machine with the same area of sail can be made of less extreme dimensions, and a considerable saving can probably be made in weight, it has the disadvantage of having less area to act as a parachute in the event of speed through the air being lost, either by a sudden lull in the wind, or through want of skill on the part of the flyer. And I am as yet not at all sure that the upper surface with a puffy wind would not, from the very fact of its high position, prove a source of danger rather than the reverse.

My reason for saying this is because I tried a machine at Cardross with the wings just above my head, but found the machine with the low wings very much more easy to handle, especially when the wind was puffy; but in order to make more sure of this, I shall probably make a double surface machine at once.

It is quite possible that what is best at Herr Lilienthal's ideal practising place, where he has his cone-shaped hill and flat country for miles round, so that his wind is unbroken and steady, is not best in the proverbially squally district of the Clyde, where I have had to experiment.

The accompanying illustration will probably make my letter more clear.

PERCY S. PILCHER.

Science and Morals.

A HABIT has been growing of recent years among certain scientific men, which many of those with whom I have discussed the subject join with me in regretting. It is this:—After the announcement of an interesting discovery, a number of persons at once proceed to make further experiments, and *to publish their results*. To me it appears fair and courteous, before publication, to request the permission of the original discoverer, who probably has not merely thought of making identical experiments, but who has in many instances made them already, and has deferred publication until some grounds exist for definite conclusions.

The late President of the Chemical Society, Dr. Armstrong, has sought to justify such conduct. On p. 225 of the *Proceedings* of that Society for 1894, these words are reported as having been used by him:—"After having been told so much, chemists could not be expected to remain under the imputation that they had been eyeless for a whole century, and they would undoubtedly inquire into the matter. Although no one would seek to take the discovery out of the hands of those who had announced it, chemists unquestionably had the right, not only to exercise entire freedom of judgment, but also to critically examine the statements which had been made."

These words related to the discovery of argon by Lord Rayleigh and myself; and, as we were otherwise occupied, no notice was taken of them. Events, I think, have justified the course which we then took. But now that all personal element has been removed, I feel free to raise the question—Is this recommendation precisely consistent with the highest view of scientific morality.

An analogy will perhaps help. If a patent has been secured for some invention capable of yielding profit, and some person repeats the process, making profit by his action, an injunction is applied for and is often granted. Here the profit of the business may be taken as the equivalent of the credit for the scientific work completed; no original idea, undeveloped, is of much value; before it produces fruit, much work must be expended; and it is precisely after the publication of the original idea, that sufficient time should be allowed to elapse, so as to give the author time to develop his idea, and present it in a logical and convincing form.

Should such trespassing on newly-sown ground come to be the rule, instead of, as I fervently hope, the exception, the result will be this:—Scientific men will provide their private laboratories with a good lock; they will communicate their ideas to none, until they are worked out; and the pleasant and friendly intercourse, which is now universal, must be abandoned. Such a state of matters would be greatly to be regretted; and it is obvious that the progress of scientific discovery would be not immaterially hindered, if every scientific man were obliged to protect himself against what, after all, comes near to a breach of the Eighth Commandment. WILLIAM RAMSAY.

University College, February 14.

The Former Northward Extension of the Antarctic Continent.

MR. BEDDARD, in NATURE for December 12 (p. 129) has called attention to a new fact, "loading still further the already over-weighted scale which now dips so deeply in favour of the Antarctic continent." Permit me to add another fact bearing on the question, but whose significance has been quite overlooked hitherto.

The most characteristic of types which occur in the cold and temperate fresh waters of the southern hemisphere is the genus *Galaxias*—a type whose representatives are popularly known as trout in New Zealand, Tasmania and Australia. Species nearly related (in one case claimed to be identical) are found in South America, and furnish the most cogent testimony in favour of a former connection of the several now isolated areas. None have been found elsewhere, and none were looked for from Africa; but in 1894 a species was described by Dr. Steindachner (*Sitzungsb. k. Akad. Wiss. Wien*, ciii., abth. 1, p. 460, pl. 3, f. 2) as *Galaxias capensis*, and there is no apparent reason to doubt that the generic allocation is correct. The geographical range of *Galaxias* is then somewhat analogous to the worm genus *Acanthrodilus*, which is the theme of Mr. Beddard's note. His remarks are applicable with even greater force to the fish genus. "It is clear that, if the former northward extension of the Antarctic continent is not believed, some explanation of these remarkable facts is much wanted; on that hypothesis they are perfectly explicable."

Lest some may think the argument in question is invalidated by the so-called *Galaxias indicus* of Day, I may add that I do not think that fish has any relation to the genus to which it was referred. THEO. GILL.

Washington, January 24.

Children's Drawings.

THERE are two little boys in my circle (nephews, in separate families), who at an early stage in their attempts at drawing, have drawn things *upside down*. Thus a locomotive would be drawn with funnel pointing downwards, and wheels at the top of the figure. Has this peculiarity been noticed before, and is it common? It seems to me interesting in relation to the subject of erect vision, for the retinal image is, of course, *inverted*.

A lady who had lived in India mentioned, in this connection, that she had often noticed natives, after taking up a photograph to look at it, replace it upside down. One of those two boys, looking at pictures, preferred to hold them upside down.

A. B. M.

Lecture Experiment on the Nodes of a Bell.

REFERRING to Mr. Taylor's letter on the above subject (January 23), the method he describes requires, in the first place, a bell-jar of very wide edge—at least half an inch—and the result, when obtained, would only be visible to one or two persons at a time. May I suggest the following method, although, very probably, by no means new.

An ordinary bell-jar with a plain edge (not welted) is fixed firmly in an inverted position; from a metal ring, arranged above it, are suspended eight small beads by fine threads, in such a manner that they rest lightly against the outside of the edge of the jar. It is convenient (though not necessary) to so arrange the beads that they touch the circle of the jar at equidistant points. On then bowing, the beads are all jerked out from their positions, and can be heard rattling against the glass as they fall back; and it is easy to note that at the nodes the disturbance is comparatively slight, while it is more violent in the ventral segments.

H. G. WILLIAMS.

Middle School, Ipswich.

THE PLANET VENUS.

THE planet Venus, as every observer knows, is a difficult and, at the same time, a tantalising object for observation, for when she is in that part of her orbit nearer to us, and therefore greatest in size, she presents us with only a small illuminated crescent, from which it is impossible to gather much from her surface markings as a whole. Although at her greatest distance from us she presents her whole disc, yet the latter appears so small that even in this case satisfactory observation is not obtainable. We have to content ourselves, therefore, with observations made between these two stages, and when her apparent disc is thus semi-illuminated.

That such an important question as the time of rotation of the planet about her axis is not yet definitely settled, is quite sufficient to indicate that the observer has not everything his own way.

In a former number of NATURE (vol. xlvi. p. 469), a summary was given of the valuable observations made by the late M. Trouvelot at Cambridge, United States, and Meudon, extending over the years 1877-1891. The chief points to which reference there was made were the two kinds of spots, white and grey, one specially prominent in size having appeared on September 3, 1876; the snow caps at the poles, and the bright specks which appeared at their southern extremities; the varying shape of the terminator, which occurred sometimes in the space of a few hours; and, finally, the period of rotation. Trouvelot found that the whitish and greyish spots were very difficult to observe, even under favourable conditions. The former were situated near the terminator, and produced on it slight deformations, which seemed so to alter it as to suggest that these spots are at a higher level than the other parts. The greyish spots, on the other hand, when situated in about the same positions, also deformed the terminator to a small extent, but in an opposite way to those just mentioned, suggesting that these spots lie at a lower level than the parts near them. Another peculiarity of these two kinds of spots which he remarked was their size. The white ones seemed to assume a round or slightly oval form, and were nearly always small, while the grey spots were generally of an elongated shape and of large dimensions, forming sometimes straight bands. That the spots were not necessarily of long duration was also remarked, and they were analogous in their formation to "taches des couches nuages continues de notre atmosphère précédant les pluies, et qu'un simple jeu de lumière fait naître ou disparaître." Their contours were described as very vague, those of the white spots being less brilliant, and those of the grey spots less dark.

In the observations that were made at the Catania Observatory and at Mount Etna (*Astr. Nach.*, Bd. 139, No. 3329), and to which a brief reference is here made, the observer, Sig. A. Mascari, describes in detail the appearances of the spots during the years 1892–1895. He also differentiates between the two kinds of spots. "Le macchie oscure si presentano ordinariamente sotto forma di leggiere velature grigie a contorni mai netti, molto deboli, senza alcun limite deciso, ed è assai raro e fortunato quel momento in cui si può arrivare a distinguere con precisione qualche contorno netto." The second type, "Le macchie chiare si rilevano per un maggiore splendore rispetto a quello del resto del pianeta.

FIG. 1.—October 12, 1892.

From the series of twenty drawings which accompany the observations in the communication referred to above, the surface markings can be clearly followed.

Fig. 1, which is one of a series of four drawings made in the months of October and November 1892, gives the general appearance of the surface as it was then observed. The three dark patches, A, B, and C, were nearly always visible; *a* was not always so prominent as is shown in the drawing. The terminator was also at times irregular in shape, being specially so on November 14. The edge of the south polar cap, near the terminator on October 13, assumed a somewhat similar appearance to that which Trouvelot recorded on September 27, 1876. The observations of the latter indicated that the most striking

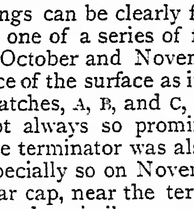


FIG. 2.—September 25, 1893.

irregularities were found at the extremities of the terminator close to the edge of the pole-caps, where deep notches were often recorded. They were of different sizes and shapes, and underwent rapid changes in periods of sometimes a few hours. These facts led Trouvelot to believe in a short period for the rotation of the planet. In the observations for 1893, the terminator was directed towards the east.

Fig. 2 shows the planet for September 25, 1893, from 13h. 50m. to 14h. 52m. The bright spot, H, is bounded on the east and west sides by dark, well-defined contours, *e*, *f*, and *m*. The region about G was somewhat obscure; the area enclosed by *i*, *m*, *n* was bright and sometimes circular, being bounded, for the most part, by dark indistinct contour lines.

Fig. 3 shows this more clearly. This drawing, made on October 13, seems to be more typical of the appearance of the disc for this year. The six comparatively large whitish spots, H, I, G, N, M, L, are here clearly shown. H is somewhat varied by an incursion of the dark contour line on the east side; I is also sometimes partially bisected by a dark streak, as was the case on November 27, 16h. 50m. (Fig. 4).

The different shapes which the terminator underwent during this year's observation were very prominent, that on November 27 being the most noticeable.

The disc in March 1895, the terminator being directed towards the east, presented the appearance shown in Fig. 5. One can easily recognise the large white spots, H, I, G, N, M; I appears, however, no longer divided,

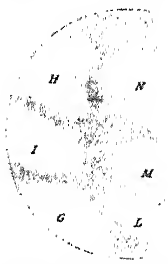


FIG. 3.—October 13, 1893.

while L seems to have more or less disappeared, giving place to a prominent circular spot a little more to the eastward. The detail observed during the months of July and August can be best seen by examining Fig. 6, which can be conveniently compared with Fig. 3 or Fig. 4.

With regard to the length of period of rotation of this planet, the difficulties of identifying the spots after brief intervals of time have rendered this point doubtful. Leo Brenner on this point writes (*Astr. Nachr.*, No 3300, p. 197): Obgleich ich bisher 107 Beobachtungen der Venus zu verzeichnen habe, konnte ich doch erst 22 Zeichnungen anfertigen, weil die wahrgenommenen Flecken gewöhnlich so schwach und unbestimmt sind,

FIG. 4.—November 27, 1893.

dass ein gewissenhafter Beobachter Bedenken trägt, ihre Wiedergabe zu versuchen, weil er fürchten muss, entweder ein Opfer von Selbsttäuschung zu werden oder die Ausdehnung der Flecke nicht richtig aufzufassen. Deshalb halte ich auch die Berechnung der Rotation aus Flecken, die so unbestimmt sind, für ganz und gar unmöglich. Anders verhält es sich aber mit Erscheinungen, welche so deutlich sind, dass sie ins Auge fallen und über deren Wirklichkeit mithin kein Zweifel bestehen kann."

It is at present uncertain whether a rotation is performed in, roughly, twenty-four hours, or whether it is accomplished in about 225 days. Trouvelot, from his numerous observations, gave a period amounting to nearly twenty-four hours; while Schiaparelli still adheres to 225 days. Quite lately also Tacchini, from observations made during last summer at the Collegio Romano, favoured Schiaparelli's view that the rotation period is equal to the sidereal revolution; and his observations (*Atti Reale Acad. Lincei*, vol. v. p. 3) towards the end of 1895, have led him to the same conclusion. The observations of Mascari seem, however, to have led him to adopt the longer of the two periods. Cerulli also, from observations made in July, August, and November of last year (*Astr. Nach.*, No. 3329) is inclined to adopt Schiaparelli's length of period. Writing in *Astr. Nachr.* (No. 3310, p. 368), he says: "Onde si conchiude che la configurazione delle ombre di Venere si mantiene sensibilmente invariabile per molti giorni, e non rivela nessun movimento conciliabile con rotazioni di breve durata."

FIG. 5.—March 23, 1895.

Leo Brenner, on the other hand (*Astr. Nach.*, No. 3314), is decidedly in favour of the shorter period, and so is therefore of the same opinion as Trouvelot. The former argues that if the spots preserve their positions, then those near the terminator would be for some length of time under the same conditions of illumination, and therefore would appear the same. This he maintains is not the case, and is not even borne out by the drawings of Schiaparelli and other observers.

It may be remembered that Trouvelot determined his value of 23h. 49m. 28s. from the observations of certain spots, but he also stated that many of the general features visible on the planet's surface, such as the rapid deformations of the horns and of the terminator, &c., a

FIG. 6.—July 26 to August 5, 1895.

suggested a short period of rotation, and were "inconciliable avec la période de rotation, si lente et si inattendue, déduite par l'éminent astronomie de Milan."

Brenner, who has observed Venus some 275 times, says that the spots move with a velocity of $15^{\circ}\cdot030$ in one hour, thus indicating a period of 23h. 57m. 7·5459s. In fact, he seems so convinced of the accuracy of his observations, that he has published a map of the surface of Venus, and finds that drawings by numerous observers agree well with it. He maintains, also, that the dark spots are true appendages on the planet's surface, and are not connected with the cloudy atmosphere. (See *Astr. Nachr.*, No. 3300, p. 198, in which he refers to a peculiar shaped spot situated near the South Pole, and a communication from Stanley Williams.

He accounts for the idea of a long period of rotation having been and still being upheld, on the ground that between 320° and 150° longitude there are several spots which are somewhat alike, six of which lie in a north and south direction, and two in higher latitudes in an east and west direction.

For this reason, if an observer does not steadily watch the planet from morning till evening every day, but simply makes an occasional observation, he can then easily mistake one spot for another, and imagine that he is observing the same one when he is really observing another, and thus conclude that no apparent motion of the spot is noticeable.

Whether this be so or not is, however, the question, but one does not feel quite at liberty to state definitely that therein lies the cause of Schiaparelli's, Tacchini's, &c., deductions of a long period, for certainly they must have convinced themselves thoroughly that such a rapid rotation, which according to Brenner is so apparent, was nevertheless to them very difficult of observation before they committed themselves to definite statements.

The following, but somewhat incomplete, list gives some idea of the views held by observers regarding the time of rotation of the planet under discussion. Column I. gives the names of those who advocate the short period of about 24 hours; column II., with one exception, those who are inclined to the period of, roughly, 225 days, and column III., those who are doubtful. The dates against some of the names refer to the times at which the respective observations were made.

I. Short period.	II. Long period.	III. Doubtful.
D. Cassini (1667)	Bianchini (1727) $>24^d$	Herschel, Sir W.
J. Cassini (1730 ?)	Schiaparelli	Beer and Mädler (1833–36)
Schröter (1788–93)	Cerulli	
De Vico (1840 ?)	Tacchini	
Trouvelot (1877–91)	Mascari	
Leo Brenner		
Stanley Williams		

During the first few months of this year the planet will be a morning star. From the middle of January to the middle of May, her time of rising before the sun diminishes from three hours to half an hour, her apparent diameter decreasing during this time from 16″ to 10″. After August she will become an evening star, her apparent distance from the sun increasing. In the middle of November she will set one hour and a half, and towards the end of December three hours, after the sun; her apparent diameter at this latter epoch being 15″.

W. J. S. L.

THE SEEBOHM COLLECTION.

THE British Museum has always owed much to the generosity of private donors, and this has been exceptionally true in the case of the collection of birds, which is now the finest in the whole world. It is difficult for ornithologists of the present day to imagine what the collection was like five-and-twenty years ago in its old quarters at Bloomsbury. Its principal value then consisted of the type-specimens which it had received from the earlier voyages, and the celebrated Nepalese collection of Mr. Brian Hodgson; but the great series of Australian birds obtained by John Gould had been allowed to go to Philadelphia, apparently without a protest from any public body in England, and to the great regret of Gould himself. He had offered the collection to the nation on reasonable terms, which were afterwards eagerly accepted by Dr. Edward Wilson, who transferred the whole series, with its priceless types, to Philadelphia.

The birds' skins in past years were kept in an underground vault, in wooden boxes, so that if any particular specimen was wanted by a student, the whole lot had often to be turned out on the table, to render possible a search for the skin required. The time thus wasted was considerable, the damage to the specimens enormous, as they were heaped one upon another in the boxes, and every skin became more or less ruffled and spoilt as time went on. As regards the mounted collection, the absurd idea obtained that the public liked to see all the rare birds, and thus all the valuable types and priceless specimens were stuffed and exhibited, there to wither with the dust and exposure to light, and decay with age. Many specimens of great value, known to have been in the collection of the British Museum at the beginning of the century, are now no longer to be found there; they have doubtless fallen to pieces from decay, and have been thrown away. Even with the utmost care, I find it difficult now to preserve some of the old Montagu collection, the skins never having been properly preserved, and having been mounted with most of the bones inside them. In this way also were preserved the specimens of Captain Cook's voyage, most of which have vanished since the time that Latham described them, and they have doubtless crumbled to pieces.

It is quite certain, therefore, that twenty-five years ago the collection of birds in the British Museum was of small repute, and probably did not exceed 40,000 specimens. Little encouragement was given to travellers to help the national collection, and, excepting in the case of the Antarctic Expedition, and a few of the same kind, the specimens received from explorers on sea and land were few and far between. The best series were in the hands of private collectors. Thus, for the study of Palæarctic ornithology, students visited my collection and that of Mr. H. E. Dresser, or that of Mr. Henry Seebohm, already then commencing to loom large. For Ethiopian birds, my own collection and that of Captain Shelley were always available for the purposes of study, and far exceeded that of the British Museum in number of specimens. For Indian birds, that of the late Marquis of Tweeddale was the one generally consulted, and in India the influence of Mr. Hume was at work, and his collection was already assuming large proportions. The collection formed by the late Consul Swinhoe was the best as regarded Chinese birds, and Dr. A. R. Wallace still retained in his hands the chief set of the specimens obtained by him during his travels in the Malay Archipelago, with all the types. The best collection of Australian birds was that in the possession of Messrs. Salvin and Godman, though Mr. Gould had a large number of valuable specimens, gathered together during the previous thirty years, since the sale of his original collection. As regards American birds, the absolute dearth of species in the national collection can be estimated from a glance at the late George Robert Gray's "Hand-list of Birds," published in 1869–71, then the authentic record of what the Museum possessed, where genus after genus is scantily represented, and the series of species is lamentably defective. With regard to those of the Neotropical region, no great Museum, in the year 1872, probably stood at a greater disadvantage than the British Museum. The majority of the types of American Passeres were in the collection of Dr. P. L. Sclater, and, for a general series, nothing in Europe could surpass that of the Salvin-Godman cabinet.

In 1896 it is interesting to note the present location of the above-mentioned private collections. They are *all* in the British Museum. With the acquisition of the Wallace collection in 1874, commenced that era of improvement in the ornithological collection which has steadily progressed, and is still progressing at the present day. The Gould, Sclater, Shelley, and Sharpe collections, with many others of greater or less importance, have passed into the hands of the Trustees. Then came, in 1885 the, magnificent donation of Mr. Allan Hume, followed by that of the Tweeddale collection

presented by Major Wardlaw Ramsay, to whom it had been bequeathed by his uncle, the Marquis of Tweeddale. Messrs. Salvin and Godman not only gave their unrivalled set of American birds, but Mr. Godman supplemented this splendid present by employing a staff of collectors to work out the ornithology of Mexico, and presented the results of their expeditions to the Museum. He also purchased the celebrated Henshaw collection, and gave it to the nation. Many other collections have since been acquired by him, and likewise presented to the Trustees of the British Museum. Only lately can it be said that we possessed in England a representative set of North American birds.

Meanwhile, although the series of Indian, African, Australian, and American birds had become adequate and representative, the ornithology of the Palæarctic region was but feebly illustrated. Through the exertions of Lord Walsingham and other English ornithologists, the nesting-habits of our British birds have been successfully demonstrated by the well-known series of groups in the Natural History Museum; but the birds of Europe and Northern Asia were poorly represented in its cabinets. By the splendid bequest of Mr. Henry Seebohm, this vacuum in our Palæarctic collections has been filled, though there is no one in the Museum who does not feel that this addition to the strength of its ornithological section has been attained only through the loss of one of the truest friends of the institution which his dying wishes have enriched. There has not yet been time to register and incorporate the specimens of the Seebohm collection, but we know that we have now received the principal collection of Palæarctic birds of modern times.

A few years ago Mr. Seebohm presented his collection of eggs, and, with this as a basis for the work, the entire series of oological specimens in the Museum was set in order and arranged under his own supervision by my daughter, Emily Mary Sharpe, till it was found that, with the Hume and Salvin-Godman collections, the British Museum could boast of a series of 48,000 eggs of birds.

In the same generous spirit, he freely gave the type-specimens of any birds he possessed, that the value of the "Catalogue of Birds" might be enhanced thereby; and now, by leaving the contents of his Museum to the nation, the British Museum becomes possessed of several invaluable additions to its ornithological collection. Thus are added: the Swinhoe collection of Chinese birds, the Pryer collection of Japanese birds, the series of specimens obtained by Holst in the Bonin and Loo-choo Islands, and Formosa; and last, but not least, his own European and Siberian collections, the result of his travels in all parts of Europe, and of his expeditions to the valleys of the Petchora and the Yenesei. Of his collection of *Charadriidæ*, he had already presented hundreds of specimens to the Museum, but by his bequest is added the series which formed his special series of the plovers and snipes, on which, indeed, was founded his great work on the geographical distribution of the *Charadriidæ*. He had, moreover, in contemplation a "Monograph of the Turdidæ, or Family of Thrushes," and in pursuance of this object he had amassed a large collection of thrushes, which now passes into the ornithological collection of the British Museum. Nests and skeletons of birds are in plenty, and a set of the Layard collection of Oceanic birds and others from the Whitehead expedition to Kina Balu, the Prjevalski and Severtzov expeditions in Central Asia, make up one of the most important donations which the Trustees of the British Museum have ever received. His series of skins of the *Phasianidæ* was one of the finest in the world, and the value of the osteological collection cannot be over-estimated, as it formed the material on which was founded his many essays on the "Classification of Birds."

In this necessarily imperfect sketch of the contents of the Seebohm collection, of which a fuller account will only be possible when it has been arranged and registered in the archives of the British Museum, it is impossible to give a detailed history of the various collections which constitute its importance to ornithologists. I feel, however, that I cannot close this article without expressing my opinion of the great loss which ornithology in general, and this country in particular, have sustained by the death of Mr. Seebohm, for, had I space to tell, it would interest naturalists to know how the great collection of birds in the Natural History Museum has been built up, by the help of such men as Henry Seebohm and the other munificent, though unostentatious, donors whose names I have recorded above. I believe, however, that under the enlightened sway of its present Director, the Museum has a still greater future before it than it has enjoyed in the past, and that when the common people have the opportunity to "read, mark, learn, and inwardly digest" the lesson which the Museum is trying to teach, the nation at large will still more fully appreciate the work of such men as Henry Seebohm.

R. Bowdler Sharpe.

MOVEMENT.[1]

Some of the results of the researches of M. Marey on the movements of men, horses, and fishes, have appeared from time to time in English papers. The skill and originality displayed by M. Marey in experimental work, involving great difficulties, must have astonished many, at a time when the idea of taking a rapid succession of photographs of a moving object was new.

The method of determining time-periods by means of a continuous chain of photographs appears to be due to Mr. Jansen, who used it in 1874 to record the transit of Venus across the sun's disc; he also suggested that the method might be applied to the study of animal locomotion. The subject of intermittent photography was attacked by Mr. Muybridge, who discovered, by means of a method different from that suggested by Jansen, the analysis of the locomotion of men, horses, and other animals. Mr. Muybridge took successive photographs of moving animals, using a battery of cameras and lenses, each plate being exposed automatically at the required instant; he also produced photographs of pigeons in flight. The end aimed at by Marey was to use a succession of photographs for chronographic purposes: photographs so taken have been called chronophotographs; his method of procedure is as follows. The object to be chronophotographed performs its movements in full sunlight before a black background of unilluminated velvet. The camera employed is furnished with a slotted disc (*disque fenêtre*) which can be uniformly rotated; as each slot cuts the beam of light reflected from the moving object, the sensitive plate receives an impression, which gives the exact form and position of the object at the instant, the duration of exposure being $\frac{1}{500}$th of a second, and the interval between the formation of each image $\frac{1}{10}$th of a second. A chronometric dial is so placed that the position of its revolving pointer is recorded on the same sensitive plate; this instrument serves to indicate both the time of exposure and the time between successive exposures, the pointer of the chronometric dial being driven at a known uniform velocity.

Provided with this instrument, and the photographic gun (which is described on pp. 108–115), and certain other special arrangements for the chronophotography of fishes, the excellent results shown in "Movement" have been obtained.

Mr. Eric Pritchard, assisted by his sister Mrs. Chalmers

[1] "Movement." By E. J. Marey. Translated by Eric Pritchard, M.A., M.B., B.Ch. (Oxon.) 323 pp., 200 illustrations. (London: William Heinemann, 1895.)

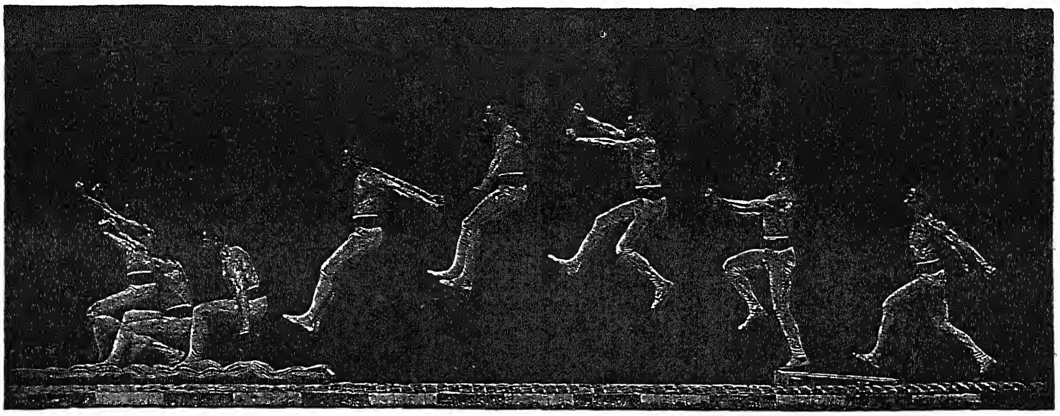
Mitchell, has produced an excellent translation of "Le Mouvement," by E. J. Marey (G. Masson, Paris), on which they may be much congratulated. The work will be most acceptable to a large number of readers widely differing in their lines of study. In many cases the details of the construction of the apparatus and its use are so clearly given, that but little difficulty should be experienced by any of those who wish to use chronophotography in researches on the movements of any animals, from elephants to microscopic insects. The translators have reproduced a large number of plates, amongst which the following seem to be good illustrations of chronophotography.

The flight of the heron (p. 233).

The arrangement of apparatus for taking three simultaneous chronophotographs of a flying bird from three points of view—from the front, the side, and from above (p. 236). By means of these chronophotographs, bas-reliefs have been constructed, showing the successive attitudes of the bird during flight.

Different figures of rotation (Figs. 15-24); amongst which that of a certain sphere (p. 30) is most curious. "The inner and outer surfaces of this sphere can be seen at one and the same time."

Fig. 92. Successive phases of a long-jump; this should be of interest to the tyro in athletics, as by it the exact position of the champion athlete may be seen at any instant.



Successive phases of a long jump. (Chronophotography on a fixed plate.)

It is much to be regretted that several plates in the French edition have been omitted, notably that of the camera and revolving disc, which shows at a glance the disposition of the different parts of one of the most important instruments; and that of the print, at the end of the French edition, called "Escrime au Bâton," which is full of life and energy, and would certainly appeal much both to the scientific and to the artistic reader.

F. J. S.

THE NEW MUZZLING ORDER.

SINCE Darwin, in his "Journal of Researches," wrote of the occurrence of hydrophobia in Central and South America, much has been learned of the nature of this disease. He says: "In so strange a disease, some information might possibly be gained by considering the circumstances under which it originates in distant climates; for it is improbable that a dog already bitten should have been brought to these distant countries." It is now known that such a possibility must receive careful consideration. In the first place, it has now been placed beyond doubt that hydrophobia is a specific infective disease, which so far as can at present be ascertained, does not originate *de novo*, but can only be introduced into a district or country by being passed on from animal to animal, different species of which, however, are affected in very varying degree. In the second place, the disease may remain latent for a long period after an animal has been infected—through a bite, usually; for this reason it is sometimes a very difficult matter to trace the infection to its source, with the result that the method of spread of the disease was for long very imperfectly understood, although the means for preventing its extension, when once it had obtained a foothold in a district, had long been elaborated and found to be thoroughly efficient when properly applied.

In this country our statistics relating to the localisation of rabies are now so full and trustworthy, that it seems to be little short of a public health scandal that the disease has not long ere this been completely eradicated from our midst. Let us take this new muzzling order, which is undoubtedly a step in the right direction. For some time past it has been perfectly well known that an outbreak of rabies was not only imminent, but had actually occurred in the north of London. The disease has made its way apparently from Essex to Middlesex, or it may be from the north, but up to the promulgation of the muzzling order, which came into force on Monday, no definite effort had been made to circumscribe the disease. We may expect that the regulations now brought into force will very soon have the desired effect of diminishing the number of animals returned as rabid; but from the experience of the Berlin authorities, we cannot expect to stamp out the disease even in London so long as Middlesex, Surrey, and the surrounding counties of Essex, Sussex, and Hampshire return cases of rabies, and any one of them fails to enforce a muzzling order. In Berlin, up to July 1853, there was no muzzling order, and in 1852 there were 107 cases of rabies reported, and up to July 1853, 85 cases. After this there was a marked fall in the number of cases; but so long as the law was merely municipal, the disease had still to be reckoned with. Since, however, the Prussian Animals Diseases Acts, 1875 and 1880, were passed (relating to the whole of Prussia), the disease has become rare, and *only occurs along the French and Russian borders*.

It is to be noted that rabies in England and Scotland is at present confined entirely to certain populous counties and centres, and that it is especially common in those districts in which dogs are favourite domestic companions or pets. On examination of the Rabies Chart for the year 1894, it is found that the majority of cases occur in Lancashire, the West Riding of Yorkshire, then, *longo intervallo*, Cheshire, London, Ayr, Lanark, and

Renfrew, and then Dumbarton and Edinburgh in Scotland, and in England, Derby, Warwick, Essex, Middlesex, Surrey, Hants, Sussex and Cornwall. The disease is strictly localised in four very definite centres, each, with the exception of that in which Cornwall is situated, containing a group of five counties. These counties are, of course, under different local authorities, so that it is impossible, in some cases at least, to obtain combine action in the matter of taking measures to stamp out the disease. It is objected that each authority must take this matter into its own hands, and act as it thinks best; but where the welfare of adjacent districts is so closely involved, as in such a case as this, some central authority might surely bring pressure to bear in order to ensure conjoint action. The Board of Agriculture, for instance, might, either by diplomacy or financial argument, compel joint action on the part of the counties situated in the above infected areas, leaving the uninfected areas free to act as they think proper. A muzzling and registration order so enforced for a couple of years would, in all probability, bring about the disappearance of rabies from our island. It is sometimes objected that the muzzle is a cruel apparatus. We have it on the authority of the most eminent veterinarians, that the cage muzzle, when properly fitted so as to allow the animal to lap water and eat grass, but not to bite, causes little or no discomfort to the dog, but that the strap muzzle, which is recommended by some of those who pose as the "friend" of the dog, is not only an uncomfortable but actually an unhealthy apparatus, as it keeps the animal from opening its mouth and getting the free use of its tongue. In Norway, Denmark and Sweden, rabies is little known; a system of quarantine is insisted upon, so that none but valuable dogs, and therefore animals constantly under observation, can gain access to these countries. Once the disease has been stamped out, it would be a comparatively easy matter to prevent its reintroduction. Even Darwin, in his time, observed that there was no hydrophobia in Van Dieman's Land and Australia, and that it only made its appearance in South America in 1803, and that it had then apparently made its way south from Central America. In the old days of long passages to these places, dogs were for long under observation before they were introduced into the new countries, and in the case of America the disease must have first appeared in the north, being introduced after a comparatively short voyage, and then gradually making its way south. Muzzling, and the taking up of unmuzzled dogs, when properly carried out, has been so successful hitherto, not only locally in this country, but generally in other countries, that the new order will be warmly welcomed by all who have studied this matter carefully, as the first step towards a really efficacious measure—combined action on the part of the authorities in the rabies areas.

NOTES.

"THE Diffusion of Metals" is the subject of the Royal Society's Bakerian Lecture, which is to be delivered to-day by Prof. Roberts-Austen, C.B., who has obtained some singular experimental results connected with the mobility of solid metals. Many experimenters in this country, especially Prof. Graham and Lord Kelvin, have studied the diffusion of gases and saline solutions, and Prof. Roberts-Austen has measured the rate at which certain metals will penetrate each other. He finds that solid gold, for instance, will diffuse into, and move about slowly in lead, even at the ordinary temperature of the air, and with considerable rapidity if the lead be warmed, though far from melted. Evidence as to the presence of wandering atoms in a solid, possesses much interest now that views as to the nature of metals and other solids have been extended by the discovery that certain rays of light will penetrate them.

THE announcement of the attainment of the North Pole by Dr. Nansen has been received with great popular interest and even enthusiasm. According to Prince Kropotkin, the correct text of the telegram which was received at St. Petersburg concerning Nansen was as follows:—"Irkutsk, January 31 (February 12).—The contractor for Nansen, Kushnareff, through the Kolymsk *ispravnik* (chief of police) Kandakoff, by mail from Yakutsk to Kirensk, and thence by telegraph, informs the *Eastern Review* that Nansen has reached the Pole, has discovered land, and returns." M. Kandakoff appears not to be the chief of the police of the Verkhoyansk district, but a "councillor to the Provincial Government of Yakutsk and a member of the Yakutsk expedition," which fact gives a much greater weight to the news. The Russian Government immediately took steps to have the truth of the report tested, but some time must necessarily elapse before authoritative confirmation is received. The absence of date and of any hint as to whether a direct message from Nansen or his crew had been received, lead us to suspect that the report may be a rumour similar to that which reported the *Fram* in the ice east of Greenland last autumn. It seems rather late in the season, even allowing for the slow rate of travelling in North-eastern Siberia, for information to come from the New Siberian Islands; while if Nansen had landed himself on the Asiatic coast, it is difficult to believe that his own dispatches should not have reached the telegraph as soon as the vague report. On the other hand, it is necessary to remember that there is nothing improbable in the news. If land intervened and stopped the drift of the *Fram*, a land expedition would certainly have been made, and the ship afterwards taken south by the clearest route irrespective of destination. She might have been frozen up at the beginning of winter somewhere within reach of the New Siberian Islands, and it is possible enough that she was visited by native hunters, who may have carried a message. While, therefore, we fully recognise the possibility of the news being authentic, and it becomes more probable as the source of the information is inquired into, we must await further information before believing that the past record of Arctic exploration has really been so brilliantly surpassed.

MR. WILLIAM W. ROCKHILL, whose journeys through Mongolia and Tibet, and his works upon them, have earned him distinction among geographers, has been promoted to the assistant-secretaryship in the State Department at Washington.

MISS CATHERINE W. BRUCE has recently made another addition to her numerous benefactions to astronomy in both Europe and America, by presenting to the University of Chicago the sum of one thousand dollars, to be used for the purpose of providing illustrations for the *Astrophysical Journal*.

THE death is announced of M. Jules Reiset, member of the Section of the Rural Economy of the Paris Academy of Sciences, and the author of many valuable contributions to agricultural chemistry and animal physiology.

A LECTURE will be delivered, on Thursday next, at the Royal Artillery Institution, Woolwich, by Dr. G. H. Bryan, F.R.S., on "Flight and Flying Machines."

THE Ethnographical Survey Committee of the British Association would be glad to receive offers of assistance from persons capable of making the requisite measurements of individuals belonging to rural populations. The Committee would supply instruments and full information. It is requested that competent observers might find it interesting to occupy themselves during some part of the Easter vacation in this manner. Applications may be made to the Hon. Sec., Mr. E. S. Hartland, Highgarth, Gloucester.

PROF. D. KIKUCHI informs us that on December 28, 1895, an Imperial Ordinance was promulgated by which a new standard time was established in Japan. The ordinance read as follows: (1) The standard time of the Empire hitherto in use shall henceforth be called the Central standard time. (2) The time of the meridian of 120° east longitude shall be the standard time of Taiwan (Formosa), Hōko group (the Pescadores), and Taeyama and Miyako groups, and shall be called the Western standard time. (3) This ordinance shall come into effect on January 1 of the twenty-ninth year of Meiji (1896).

THE Hayden Memorial Medal of the Philadelphia Academy of Natural Sciences has been awarded to Prof. Karl von Zittel, whose services to the sciences of geology and palæontology extend continuously over a period of thirty years. Born in 1839, Prof. von Zittel was, at the age of twenty-four, appointed to the Professorship of Mineralogy at Karlsruhe, and three years later to the Professorship of Palæontology at the University of Munich, a position, jointly with that of Director of the Palæontological Museum, which he still holds. His published works cover a large range of personal investigation, not the least important of which are the researches into the structure and physiography of the Libyan Desert and the Sahara, and his monumental work, "Handbuch der Paläontologie," which has not long been completed.

THE work of the Marine Biological Association at Plymouth has, for a number of years, been carried on under great difficulties, owing to the want of a suitable steamboat capable of working in the Channel. We are glad to be able to announce that this difficulty has now been overcome by the purchase of the steam fishing yacht, *Busy Bee*, from Mr. C. E. Treffry, of Fowey. The vessel is 56 feet long, with a registered tonnage of 7·9, and is a good sea-boat, capable of going anywhere in the English Channel. With the increased facilities for marine work which will thus be offered, it is hoped that a still larger number of naturalists will visit the Laboratory. Applications for the use of tables during the Easter vacation, including, when desired, participation in the dredging and trawling work to be carried on by the new yacht, should be sent without delay to the Director.

WE regret to notice the death, on Sunday, of General J. T. Walker, C.B., F.R.S., whose work as Superintendent of the Great Trigonometrical Survey, and Surveyor-General of India, is widely known and appreciated. From an obituary notice in the *Times* we learn that he was born in 1826, and entered the Bombay Engineer Corps in 1844. He joined the Trigonometrical Survey in 1852, and, except for a short time during the Mutinies, he was incessantly employed on work connected with it, under Sir Andrew Waugh, until he succeeded that officer as Superintendent in 1861. He held this post for twenty-two years, combining with it during the last five years the Surveyor-Generalship and the charge of the Revenue Surveys. He continued and completed the original scheme of the Great Trigonometrical Survey, and conducted numerous collateral operations connected with it. General Walker's labours were not confined to geodesy. He was in the first rank as a geographer. On retiring from India in 1883, he became an active member of the Council of the Royal Geographical Society, and was an authority on all questions relating to Central Asia. Last July he took a leading part in the geodetical business of the International Congress, and was doing useful geographical work up to within a short time of his death.

WE cordially welcome the *Centralblatt für Anthropologie, Ethnologie und Urgeschichte*, edited by Dr. G. Buschan, as supplying a real need. Other sciences, such as zoology, botany, or chemistry, have journals the aim of which is to keep their readers abreast with the literature of their respective subjects. Till now the very comprehensive study of anthropology has been without such a necessary journal, although several anthropological serials make a point of giving some idea of current literature. Dr. Buschan has secured the co-operation of a large number of colleagues, which will ensure catholicity in the selection of notices. There are to be a few quite short original articles, and various items of general interest and personal notices. This first number contains short, clear notices of 112 papers and books. We hope that the "bibliographische Ubersicht," which is promised, will give the current literature as exhaustively as is possible. If this is done, the new journal will be of the greatest value to all those interested in the study of man.

AT the annual meeting of the Royal Astronomical Society, on Friday, the gold medal of the Society was awarded to Dr. S. C. Chandler for his many astronomical investigations, and especially for his work in connection with the variations of latitude.

THE successive deaths, following so soon one after the other, of the two great American systematic botanists, Dr. Asa Gray and Dr. Sereno Watson, suspended the publication of their great Synoptical Flora of North America, of which two parts were published, and were reissued by the Smithsonian Institution in 1886. Arrangements have now been made for carrying on the publication, and a fascicle of upwards of 200 large octavo pages is published, under the editorship of Dr. B. L. Robinson. It comprises the orders of Polypetalæ from Ranunculaceæ to Frankeniaceæ.

ACCORDING to the recent investigations of Dr. R. F. Kaindl (*Globus*, lxix., 1896, pp. 69, 90), the Huzulen retain many primitive customs; these people are Slavs who inhabit the Galician Carpathians, and are nominally Roman Catholics. Everywhere one comes across wooden crosses erected over buried brandy-bottles. In 1894 a "Brandy-prophet" appeared; he was a simple peasant who waged a successful warfare against brandy-drinking. The zeal of the people constrained the clergy to bury the spirit with ceremonies; and now in this country the use of brandy has ceased; and the words of an old Huzulen may be true, that at the present time only those drink brandy who are worth nothing. A gypsy, who had sent his wife away, bought the daughter of a Huzulen for fifty florins; he was had up by the magistrate, but that had no effect; in a year he was tired of her, and then he hired the wife of another Huzulen for sixty florins: again the law was powerless, and at the end of the year the husband came for his wife. There are two remedies for back-ache—one is for the priest to walk on the patient's back in church, and the other is to let a bear walk on it. Weasels, snakes, frogs, puppies, and kittens may not be killed, and there are numerous charms against the two first. For three days before the Huzulen moves into a new house he throws a black hen on it, so that snakes may not nest there. Black cattle are lucky. The mentioning of certain words for simmering and boiling is prohibited when applied to milk, lest harm should come to the cows. The grave-diggers and coffin-makers wash their hands over a grave to signify that they are not to blame for the sorrow, and the relatives ask the latter not to be angry with the dead for the trouble he has caused them, and not to ask for payment from him in the next world. Several original sketches illustrate this article.

GEOLOGY and agriculture, as well as meteorology, writes Prof. Abbe in the *Monthly Weather Review*, are interested in the part played by the small quantity of carbonic acid gas that exists in the atmosphere. The leaves absorb and assimilate a portion; the falling raindrops and the surface water of the ocean absorb

another portion; it is exhaled from the lungs, and given off in still greater quantities from every burning substance. It may accumulate temporarily in some regions, but the slow diffusion and swifter winds carry it away. It ought to diminish as we ascend above the earth's surface, but the rapidly rising and falling currents of air tend to preserve a fairly uniform mixture very much as they do in the case of aqueous vapour. Evidently there is a general balance between the production and absorption of carbonic acid gas, so that, like the temperature of the air and the quantity of rain or any other meteorological element, we find no great progressive secular increase or diminution. An article in *Wollny's Forschungen* (1895, vol. xviii. p. 409) reviews the latest additions to our knowledge of the distribution of carbon dioxide in air. A comparison of the proportion of the gas in samples of air obtained near the earth's surface with that of samples collected by S. A. Andrée at various altitudes, failed to prove any diminution of carbon dioxide with altitude up to the highest point, 4300 metres, obtained in the balloon ascensions. On the other hand, the percentages of the gas by volume throughout the different strata of air, are very much the same as those observed at the surface of the earth. An apparent dependence upon the wind was, however, suggested by the results, and when the percentages were discussed from that point of view, the general conclusion arrived at was that a descending mass of air brings with it a higher percentage of carbonic acid gas, which is subsequently diminished by absorption near the earth's surface, so that the ascending current has a smaller percentage. The question here raised is one of great importance in the theory of the interaction of the atmosphere and the earth, and it can only be brought to a definite solution when the greatest possible number of investigations into the percentages of carbonic acid gas in the atmospheric strata are carried out by means of balloon voyages.

UNDER the sensational title of "Longitudinal Light," a paper by G. Jaumann appears in *Wiedemann's Annalen der Physik und Chemie*. It is based upon the law of electric discharge enunciated by the same writer in 1888, according to which electric waves impinging at right angles upon a kathode surface favour the dissipation of the charge upon it. This was proved experimentally by Hertz in the case of ultra-violet light, and by Elster and Geitel in the case of ordinary light impinging upon a liquid electrode in a vacumn. Wanka also proved it in the case of electro-magnetic waves. Hence, so the writer argues, light vibrations must have a component in the direction of propagation; they must, in fact, contain longitudinal as well as transverse waves. That this is so, is made extremely probable by the analogy of kathode rays. The latter have the vibration period of waves in wires, and are therefore pretty certainly longitudinal. Now comes the question how Maxwell's electromagnetic equations, which do not admit of any but purely transverse vibrations, can be made to agree with these conclusions. Jaumann gives a simple answer. Let it be admitted that the specific induction capacity of a medium and its magnetic permeability are affected by the oscillations themselves. These "constants" will then be variable, and when introduced as such into the equations, longitudinal vibrations are at once seen to be possible. Each pencil of light will then be vibrating transversely along its centre line, and towards the outer edge the vibrations will become more and more longitudinal. This theory is a distinct innovation; but the author claims that it affords a natural and simple explanation of a large number of discharge phenomena. Thus the curious diffused reflection of kathode by a plane surface is easily reduced to the fact that Huyghen's principle of reflection no longer holds good.

ALTHOUGH we may still identify a particular disease with a particular microbe, yet there can be no doubt that the part played by other microbes associated with pathogenic germs is of very great importance in determining the course pursued by the disease. The co-operation of bacteria is, therefore, a subject which is gradually more and more occupying the attention of bacteriologists, and in the last document issued by the Russian Imperial Institute of Preventive Medicine, M. Maschevsky has published a very extensive series of investigations on the effect upon the cholera bacillus of cultivation in the presence of other microbes. Several varieties of bacteria were isolated from the intestinal tract of man and animals, as well as from apples and cucumbers, and with these the cholera bacillus was then grown. The number of bacteria from these sources in themselves proved to be harmless, but which served to exalt the virulence of the cholera bacillus, appears to be very considerable. Perhaps one of the most interesting results is the discovery that cholera bacilli which had lost their virulence, regained it completely when associated with perfectly harmless bacteria isolated from apples and cucumbers. M. Maschevsky considers, therefore, that he has discovered a scientific basis for the popular prejudice which condemns the consumption of uncooked fruit and vegetables during epidemics of cholera. Prof. Metchnikow has already dwelt at considerable length upon the effect produced by the nature of the bacterial flora present in the intestine upon the virulence of cholera bacilli, and seeks to explain in this manner what may be described as some of the "vagaries" of cholera epidemics. The whole subject is one of great importance, but one which, involving as it does experiments of the most extensive and laborious nature, still requires an immense amount of work to place on a satisfactory basis. M. Maschevsky's investigations must be regarded as an important contribution in this direction.

MESSRS. CROSBY LOCKWOOD AND SON have nearly ready for publication a volume entitled "Light Railways for the United Kingdom, India, and the Colonies," by Mr. John Charles Mackay.

TO the Hand-list of Orchids cultivated at the Royal Gardens, Kew, which has just been issued, is prefixed a preface giving an interesting historical sketch of the cultivation of orchids in this country. In the year 1890 as many as 766 species belonging to the order flowered in the Gardens.

THE first part of a "Géométrie Descriptive," by M. A. Gouilly, dealing with the geometry of points, straight lines, and planes, has been published jointly by MM. Gauthier-Villars and G. Masson, in the Aide-mémoire Series. The second volume of the work will be concerned with the sphere, cone, and cylinder of revolution, and conic sections; while changes in planes of projection and rotation will form the subject of the concluding volume.

THE *International Journal* of Microscopy and Natural Science, the fifth volume of which (third series) has lately been issued, contains many important contributions to the knowledge of nature in the animal, vegetable, and mineral worlds. The *Journal* is the organ of the Postal Microscopical Society, and is edited by Mr. A. Allen, with the assistance of three associate editors, viz. Prof. V. A. Latham (Chicago), Mr. J. S. Brown (Montreal), and Dr. F. Vicentini (Chieti). Naturalists generally, and workers with the microscope, will find much interesting and serviceable information in the new volume.

WHEN the Austrian Government took over the administration of Bosnia and Herzegovina in 1879, meteorological observations were commenced at a few stations, the number of which has now increased to seventy-seven; three of these are of the first order, or provided with complete self-recording instruments. The Government of these Provinces has recently published its first volume, containing hourly observations and curves for

Sarajevo and Mostar, daily observations at four stations, and monthly and yearly results at all the stations, for the year 1894. A fully-equipped mountain observatory has also been established on the Bjelasnica (lat. 43° 42′ N., long. 18° 15′ E.), at an altitude of about 6800 feet; the publication of these results will commence with the next volume.

THE Kew *Bulletin of Miscellaneous Information* often furnishes us with material for notes; and in looking through the volume containing the numbers published during 1895, we are struck with the large amount of valuable information to be found in its pages. Kew has trained and sent out botanists to botanic gardens in most parts of the world, and it is chiefly due to them and the Director of the Royal Gardens, that the *Bulletins* are able to do so much to extend the knowledge of economic plants. The services thus rendered to the national welfare, by the publication of exact information with reference to botanical enterprise and the potentialities of newly-explored regions, cannot be over-estimated. All who wish to see how science can assist in developing the resources of our colonies, are advised to turn to the 1895 volume of the *Bulletin* of the Royal Gardens, and they will not be disappointed.

THE "Electrical Trades' Directory and Handbook for 1896" (14th year), published at the office of *The Electrician*, furnishes wonderful evidence of the extent of electrical industries at the present time. It consists of over five hundred pages of handbook matter, and nearly seven hundred pages of directorial information. The volume is invaluable to all who are concerned with the production and supply of electricity. Another handy book for electrical engineers and contractors is "The Universal Electrical Directory," published by H. Alabaster, Gatehouse, and Co. This publication, which has now reached its fifteenth year, contains a complete record of all the industries directly or indirectly connected with electricity and magnetism, and the names and addresses of manufacturers at home and abroad.

THE *Quarterly Statement of the Palestine Exploration Fund* (January 1896) contains the usual detailed record of careful exploring work. Of more general interest is the adventurous expedition of Mr. and Mrs. Gray Hill to the isolated and remarkable Crusaders' Castle of Khauranee, of which photographs are given. Lieut.-Colonel C. M. Watson has attacked the problem of the position of the Temple of Jerusalem. He states his views with much plausibility; his method is the scientific one of first considering the historical written evidence, and then the levels of Mount Moriah as it originally existed before Solomon began to build the Temple; and he has drawn his plans in accord with the historical documents, and also with what exploration has shown to be the actual facts. Lieut.-Colonel Conder has an essay on the Syrian language and the history of Samâla.

DR. G. BROWN GOODE's report upon the condition and progress of the U.S. National Museum, under the direction of the Smithsonian Institution, during the fiscal year ending June 30, 1893, has come to hand. The report is especially noteworthy on account of the description Dr. Goode gives of the development, organisation, scope, and work of museums generally, and the National Museum in particular. The description is lavishly illustrated by full-page plates reproduced from photographs of objects and cases in the museum. Bound up with the report are ten papers describing and illustrating collections in the National Museum, among them being "The Poisonous Snakes of North America," by L. Stejneger; "The Onyx Marbles," by G. P. Merrill; "The Cowbirds," by Major C. Bendire; "The Weapons and Wings of Birds," by F. A. Lucas; and "Ethnology of Tibet," by W. W. Rockhill. These papers, which are accompanied by numerous full-page plates, are most valuable contributions to knowledge. The papers, together with Dr. Goode's report, fill nearly eight hundred pages, and the whole stands as striking evidence of the liberality of the Smithsonian Institution in matters of publication.

THE third annual report (vol. iv.) of the Iowa Geological Survey, dealing with the work accomplished under the auspices of the Survey during 1894, has been received. The report shows that a large amount of valuable information was accumulated with reference to the geological structure, and geological products of economic importance, in several counties of the State of Iowa. The method followed by Dr. Samuel Calvin, the State geologist, is to give reports of the geological features of each county separately. He recognises, of course, that this involves following an artificial subdivision of the State; for county boundaries have no relation to the distribution of geological formations. But, at the same time, he points out that the present citizens, as well as prospective settlers and investors, think not of naturally-defined areas, but of counties in which they become interested; and they will turn to the geological report of the several counties under consideration for information concerning the resources of them. Dr. Calvin reports that the work of the Survey continues to demonstrate that the Iowa coal-measures are far richer than they have been believed to be. The report is illustrated by numerous maps and figures, and is standing evidence of the vigour and thoroughness with which the work of the Survey is carried on.

AMONG the many interesting articles and notes in the number of the *Asclepiad* just issued (No. 44, vol. xi.), is a biographical paper on Dr. Thomas Young, by Sir B. W. Richardson, accompanied by a fine autotype portrait of him. Dr. Young is perhaps better remembered by his optical observations than for his medical researches. His mind was turned towards natural philosophy, and it was in that domain rather than in his profession that he earned distinction. He did, however, make some contributions to medical science. About the year 1813, he wrote an essay on the medical facts of climate, containing a large amount of valuable information. In the same year he prepared an introduction to medical literature, including a system of practical nosology, and his essay on consumption attracted considerable attention. Throughout his life he was a close student of vision and of the eye, and in the Bakerian Lecture which he delivered before the Royal Society in the first year of this century, he entered largely into the dimensions and refractive qualities of the eye, and the size of the pictures which are developed on the retina. It was in physical investigations that Young excelled, and especially in connection with interference and the wave-theory of light. He died in May 1828, after just completing his fifty-sixth year.

The current number of the *Berichte* contains an interesting historical note, by Dr. G. W. A. Kahlbaum, on the origin of the "Liebig's Condenser." The inventor of this indispensable piece of apparatus appears to have been C. E. Weigel, Professor of Chemistry and Botany at Greifswald. The account of this apparatus, with diagram, a facsimile of which is reproduced in the *Berichte*, first appeared in 1771, thirty years before Liebig was born. It should be noted, however, that Liebig never described this condenser as his own, but called it Göttling's; and the latter, again, who seems to have made these condensers for Liebig, distinctly refers its invention to Weigel. On these grounds, Dr. Kahlbaum thinks it should be henceforth known as "Weigel's Condenser."

THE chemistry of the simpler organic fluorine derivatives, after a period of comparative neglect, has during the last few years been vigorously followed up, more especially in France. At the meeting of the French Academy of Sciences on February 3, two papers were presented on the acid fluorides, one

by MM. M. Meslans and F. Girardet, the other by M. A. Colson. In the first paper, the method previously used with success by M. Meslans in the preparation of other organic fluorine derivatives, the treatment of the corresponding chloride with metallic fluorides, was employed. M. Colson used a rather different method, the action of the halogen acid upon the organic acid in presence of a dehydrating agent. With hydrogen fluoride, the anhydride of the organic acid gives the best results; thus with acetic anhydride the reaction is

$$(CH_3.CO)_2O + HF = CH_3.CO.F + CH_3.CO.OH.$$

The operation, which must be carried out in a freezing mixture in a metallic flask, gives a theoretical yield. Acetyl fluoride boils at 20°·8 under a pressure of 770 mm., and its density at 0° is 1·0369. Propionyl fluoride boils at 44°, and is lighter than water, its density at 15° being about 0·972. Benzoyl fluoride, which has already been prepared by M. Guenez, is best obtained by acting with benzoyl chloride upon dry zinc fluoride, and is a liquid of extremely irritating odour, boiling at 154°.

THE additions to the Zoological Society's Gardens during the past week include a Common Viper (*Vipera berus*), British, presented by Mr. S. Ockenden; four Japanese Teal (*Querquedula formosa*, ♂ ♂ ♀ ♀) from North-east Asia; two Smews (*Mergus albellus*, ♂ ♂), European, a Black Lark (*Melanocorypha yeltonensis*) from Siberia, purchased; a Purplish Death Adder (*Pseudechis porphyriaca*), a Punctulated Tree Snake (*Dendrophis punctularia*) from Australia, deposited; a Hybrid Pheasant Antelope (between *Tragelaphus gratus*, ♂, and *Tragelaphus spekii*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

PERRINE'S COMET.—A telegram from Kiel announces the re-discovery of Perrine's comet by Dr. Lamp, on February 13. At 17h. 40m., Kiel mean time, it was in R.A. 19h. 44·8m. and decl. −2° 22'. The R.A. agrees well with the ephemeris published in NATURE on January 23, but the south declination is about a degree greater than that predicted.

A NEW COMET.—Another telegram from Kiel is as follows: "New comet Perrine Lamp, February 15, 17h. 28·6m., Kiel mean time; R.A. 19h. 26m. 44s., decl. −1° 1' 56"; daily movement in R.A. 7m. 36s., in declination 2° 57' towards the north: bright." The new comet is thus in the immediate neighbourhood of the original Perrine's comet, but it has a much more rapid movement. Both comets are in the constellation Aquila, rising about 4 a.m.

THE ZODIACAL LIGHT.—During the last three years the zodiacal light has been very carefully observed by E. Marchand, under the advantageous conditions afforded by the observatory of the Pic du Midi, at an altitude of 2860 metres (*Bull. Soc. Ast. de France*, February). Ordinarily this phenomenon is best seen during the evenings of spring or in the mornings of autumn; but in the absence of the moon, when the sky is clear, it is seen at all times of the year from the mountain observatory, completely encircling the celestial sphere. The limits of the luminosity have been plotted on charts, and taking the mean positions of the boundaries, it is found that the width of the belt of light is about 14°, and that it is very nearly a great circle inclined 6° or 7° to the ecliptic, with a longitude of about 70° for the ascending node. Now the inclination of the sun's equator is about 7°, and the longitude of the ascending node is about 74°; hence, it is concluded that the central plane of the zodiacal light coincides with the plane of the sun's equator.

The observations support the idea that the attenuated cosmical matter of which the zodiacal light is probably composed extends all round the sun, in the form of a very flattened ellipsoid of revolution, to a distance well beyond the earth's orbit.

In the part of the sky opposite to the sun, the brightness of the light is not greater than that of the most feeble parts of the Milky Way, but it becomes much more intense as the sun is approached. The increase of brightness in the direction of the sun, however, is more rapid than can be accounted for merely by the increased thickness observed, so that a greater condensation of cosmical matter in the neighbourhood of the sun seems probable. Near the horizon, the width of the zodiacal light seems generally greater than that which traverses the sky; but it is pointed out that this may be due to the same cause as that which makes the sun, moon, or constellations appear larger when near the horizon. The "Gegenschein," or counter-glow, does not appear to have been noted.

SURFACE DRIFT OF JUPITER.—A useful summary of the various determinations of the rotation period of Jupiter in different latitudes is given by Mr. Stanley Williams (*Monthly Notices*, lvi. No. 3). Nine distinct currents can certainly be recognised, and their boundaries are pretty sharply defined, though possibly varying slightly in position from time to time. These currents, with the exception of that including the red spot, completely encircle the planet, travelling due east and west, and giving little or no indication of any movement towards or from the poles. In the following tabular statement the number of the zone or current is followed by the zenographical latitudes of its boundaries; then follows the average rotation period of the zone expressed in time and in terms of the equatorial period.

Zones.	Lat.	Period. In time. h. m. s.	Period. In terms of equatorial period.
I.	+85° to +28°	9 55 37·5	1·0089
II.	+28 ,, +24	9 54 30	1·0071
		9 56 30	1·0104
III.	+24 ,, +20	9 48 0 9 49 30	0·9973
IV.	+20 ,, +10	9 55 33·9	1·0089
V.	+10 ,, −12	9 50 20	1·0000
VI.	−12 ,, −18	9 55 40	1·0090
VII.	−14 ,, −28	9 55 40	1·0090
VIII.	−18 ,, −37	9 55 18·1	1·0084
IX.	−37 ,, −55	9 55 5	1·0081

There is a remarkable want of symmetry in most of the currents. In the northern hemisphere the drift is nearly uniform from the pole to lat. 28°, and there is nothing equivalent to the red spot (zone VII.); in the southern hemisphere there is no counterpart of the region about lat. 25°, which is such a prominent feature in the northern hemisphere. It is suggested that atmospheric circulation in a north and south direction may take place through the narrow rifts which have been seen to traverse obliquely some of the belts and clear zones.

THE TEMPERATURE OF AIR AND THE PROBLEM OF AN ICE AGE.[1]

THE mean temperature t of the air is determined by the balance of radiations received from the sun and from the soil with that given up towards the sky, and is ruled by the action of meteorological factors. According to Maurer's and Trabert's discussion of nocturnal temperatures, air radiation in the atmosphere is a *linear* function of its temperature; so radiations from soil and towards sky are expressed as proportional to the differences $[(t_s - t), (t - t_c)]$ of t from the mean temperature t_s of soil, and from the mean temperature t_c of an ideal stratum, the radiations of which would be equivalent to that of the whole atmosphere and of all the celestial bodies except the sun. This temperature t_c I call *temperature of the sky*.

Similarly, the mean temperature t_s of soil is determined (if we abstract from meteorological agents, that is in *solar climate*) by the balance of its radiation towards the sky [which is proportional to $(t^s - t_c)$] with that fraction of mean solar heat which is bestowed upon heating the surface considered. The mean annual solar heat received by unity of surface at the limits of the atmosphere (which is 0·305 of the solar constant at the equator) diminishes with the latitude λ, not as cos λ, but, according to Wiener's computations, as the cosine of an auxiliary angle ζ, which is 0° at the equator, and 65° 31' at the poles, and which repre-

[1] I beg permission to briefly review the assumptions upon which Section II., III. of "Le Cause dell' Era Glaciale" (Pavia, 1865) is based, and which the reviewer of the book in NATURE (No. 1348, vol. lii. p. 412) judged as far from satisfactory.—LUIGI DE MARCHI.

sents zenithal distance of a fixed sun, the intensity of which would be 3/10 of the true intensity, and the annual effect of which would be equivalent to that of the true sun. At sea-level this quantity of solar heat is supposed to reduce itself, according to Bouguer's law, from 1 to $p^{\sec \zeta}$, where p is the mean transparence of the atmosphere.

Upon these assumptions, the *annual solar temperature* of the air on a *continental* globe is expressed (omitting here a little term for diffused heat) by a formula $t_1 = t_c + k_s \cos \zeta \frac{p^{\sec \zeta}}{m_s}$ where m_s is the transparence of the atmosphere for the earth's radiations, and k_s is a coefficient proportional to the *heating power* of solar radiation for soil, and depends then upon the physical constitution of the latter. On the sea the effect of solar heat is most complicated, but, abstracting from currents, arguments are given for accepting on *oceanic* globe a formula $t_0 = t_c + k_a \frac{p^{\sec \zeta}}{m_a}$, where m_a, k_a are the analogues of m_s, k_s for sea. Forbes expresses the mean temperature of each parallel by $t = t_0 + x(t_1 - t_0)$, when x is the fraction of parallel occupied by continents; but the same formula may express the mean temperature of every point on continents, if x means its *continentality*, whose expression by annual range e $\left(x = \frac{e - e_0}{e_1 - e_0}\right)$ is discussed.

The calculation of coefficients in the complex formulæ so obtained is very much simplified by comparison with known empirical formulæ. Mendeléef's formula for vertical distribution of temperature leads to the fundamental fact that the mean temperature of the sky, t_c, is a constant for all points at sea-level, and from evaluations of Mendeléef's constant by Woeikof I assume it as $-45°\cdot4$ C. ($-49°\ 7$ F.). So is numerically expressed what Mr. Culverwell calls the *blanketing* function of atmosphere, and its function of conforming temperature on the earth's surface; and Croll's fallacy of evaluating effects of solar heat by differences from a hypothetical temperature of space is placed in evidence. Values of t_0, t_1 at equator, discussed from Forbes' formulæ, give values of $\frac{k_s}{m_s}$, $\frac{k_a}{m_a}$; p is assumed as 0·60.

Solar temperatures so obtained give a very satisfactory representation of facts; their differences from true temperatures are a striking reflex of the distribution of meteorological and physical agents (sea and air currents, convective motions, shore-ice, &c.) not accounted for in deduction of formulæ.

An attempt is made for a theory of annual range, where Wilson's principle of the constancy of nocturnal cooling of bodies, whatever may be the temperature of the air, allows the assumption that the temperature of the sky follows in its variations temperature of soil. Comparison of theory with facts indicates the enormous smothering influence of meteorological agents.

Discussions of astronomical and geographical theory of an Ice Age, in the light of the formulæ given, accounts for variability of physical and meteorological agents. None seems to me to satisfy either the theory or the actual conditions for variation of climates, as developed *on facts* by Brückner's classical work on "Klimaschwankungen." These conditions seem to the author to be satisfied by the suggestion of a small *diminution* in the transparence p, attended by a proportional, or by a smaller, diminution of m_s, m_a. So the difference $t - t_c$ is diminished, less at low latitudes, more at higher, above all at 70° Lat., the variation diminishing further. Diminution is greater on sea and less on continent, so diminishing at high latitudes thermic difference between earth and sea, what is, according to Brückner's demonstration, the capital condition for a rainy period on continents, and indirectly for glaciers pushing forward. Also the difference between equator and poles is strengthened.

Inversely, an increase of p and m_s m_a would bring, as in Tertiary periods, a more equal distribution of temperature between equator and poles, by increasing for several degrees the temperature in higher latitudes. Mars is probably in a similar condition, as polar ice-caps do dissolve, notwithstanding that the intensity of sun is there much less than on earth; but the Martian atmosphere is extraordinarily more transparent than ours. Annual range would be strengthened; but the flora of East Siberia suggests that also Heer's polar floras might have sustained severe winter, provided that summer's heat was sufficient to support them, and that abrupt variations were avoided.

THE RÖNTGEN RAYS.

THE field of investigation opened up by Prof. Röntgen's researches on the new actinic rays has attracted explorers from all parts of the civilised world. So numerous are the communications being made to scientific societies that it is difficult to keep pace with them, and the limits of our space would be exceeded if we attempted to describe the whole of the contributions to the subject, even at this early stage. It may assist, however, in the organisation of the facts if we bring together a few of the results obtained since the publication of Prof. Röntgen's paper.

The most important British communication on the subject was made by Prof. J. J. Thomson to the Royal Society on Thursday last, in the following paper, on the "Discharge of Electricity produced by the Röntgen Rays, and the effects produced by these Rays on Dielectrics through which they pass."

"The Röntgen rays, when they fall upon electrified bodies, rapidly discharge the electrification, whether this be positive or negative. The arrangement I have used to investigate this effect is as follows: The Ruhmkorff coil and the exhausted bulb, used to produce the rays, are placed inside a large packing case covered with tin plate; this is done to screen off from the electrometer any electrostatic disturbance due to the action of the coil. The needle of the electrometer is suspended by a quartz fibre; thus, as there is no magnetic control, the needle of the electrometer is not affected by changes in the magnetisation of the core of the coil.

"The exhausted bulb is placed so that the phosphorescent part of it is about $1\frac{1}{2}$ inches from the top of the box, and a hole about an inch in diameter is cut in the lid of the box just over the bulb, so as to allow the rays to emerge from the box: a thin plate of either aluminium or tinfoil is used to cover up the hole. The electrified plate, which is a little larger than the hole, is placed outside the box about two inches above the hole in the lid, so that the Röntgen rays which passed through the hole fall upon the plate. This plate is kept permanently connected with one of the quadrants of a quadrant electrometer; the greatest care is taken with the insulation of this plate and of the quadrants of the electrometer. The insulation was so good that there was no appreciable leak when the coil was not in action. The following is the method of making the experiments: The two pairs of quadrants are connected together, and the plate charged to a high potential by an electrophorus, or by temporary connection with a large battery of small storage cells. All the quadrants of the electrometer are now at the same potential. The two pairs of quadrants are now disconnected; if the insulation is good the potentials will remain the same, and there will be no deflection of the electrometer; in our experiments the leak is so small that under these circumstances the movement of the spot of light is hardly perceptible. If, now, the Rontgen rays are directed on to the plate a violent leakage of electricity from the plate occurs, the potential of the quadrants connected with the plate changes, and in a few seconds the spot of light reflected from the mirror of the electrometer is driven off the scale. This leakage of electricity occurs whether the plate is positively or negatively electrified; if the plate is uncharged to begin with, I have not been able to detect that any charge is acquired by the plate by exposure to these rays. When the potential to which the plate is raised is high the leakage from the plate is a most delicate means of detecting these rays, more so than any photographic plate known to me. I have found these rays produce distinctly perceptible effects on a charged plate after passing through a zinc plate a quarter of an inch thick. The charged plate and electrometer are much more expeditious than the photographic plate and more easily adapted to quantitative measurements.

"To determine how the radiation of the Röntgen rays depended upon the degree of exhaustion of the bulb, the bulb was kept in connection with the pump and the leakage was observed at different degrees of exhaustion; no leakage could be detected until the pressure was so low that phosphorescent patches appeared on the bulb, and. even after the phosphorescence appeared, the leakage was small as long as there was any considerable luminosity in the positive column; it was not until this had disappeared that the leakage from the charged plate became rapid.

"If the greatest sensitiveness is required, it is, of course, advisable to charge the plate as highly as possible. The leakage due to

the rays, however, occurs when the potential of the plate does not exceed that of the tin-plate cover by more than 3 or 4 volts, and I have not yet met with any phenomena which suggest that there is a lower limit of potential difference below which leakage does not take place.

"This leakage differs from that produced by ultra-violet light, the laws of which have been unravelled by Elster and Geitel, in several essential features, in the first place ultra-violet light only discharges a negative charge, while the Röntgen rays discharge both positive and negative. Again, the effect of ultra-violet light is only considerable when the electrified body is a strongly electro-positive metal with a clean surface. The effects of the Röntgen rays are, on the other hand, very marked whatever the metal, and take place when the electrified plate is surrounded by solid or liquid insulators as well as when surrounded by air. I have embedded the plate in solid paraffin wax, in solid sulphur, placed it inside a lump of ebonite, wedged it in between pieces of mica, and immersed in a bath of paraffin oil; in each of these cases, though the insulation was practically perfect when the insulator was not traversed by the Röntgen rays, and the potential of the plate differed from that of the metal covering of the box by from 10 to 15 volts, yet, as soon as the Röntgen rays passed through the insulator, the charge of the metal plate leaked away. I have found that the electricity leaks from the plate even when the space between it and the nearest conductors connected to earth is entirely filled with solid paraffin; hence we conclude that when the Röntgen rays pass through a dielectric they make it during the time of their passage a conductor of electricity, or that *all substances when transmitting these rays are conductors of electricity*. The passage of these rays through a substance seems thus to be accompanied by a splitting up of its molecules, which enables electricity to pass through it by a process resembling that by which a current passes through an electrolyte. By using a block of solid paraffin in which two pairs of electrodes were embedded, the line joining one pair being parallel, that joining the other pair perpendicular, to the Röntgen rays, which were kept passing through the block, I found that there is but little difference between the rate of leakage along and perpendicular to the rays."

Prof. Thomson has investigated the question of longitudinal vibrations in connection with the recent discoveries. In a paper read before the Cambridge Philosophical Society on January 27, he discussed the theory of longitudinal waves from the point of view of the electro-magnetic theory of light, and showed that on that theory longitudinal waves can exist (1) in a medium containing moving charged ions; (2) in any medium, provided the wave-length is so small as to be compared with molecular dimensions, and the ether in the medium is in motion. It was shown that it follows from the equations of the electro-magnetic field that the ether is set in motion in a varying electric field. These short waves would not be refracted, but in this respect they do not differ from transverse waves which on the electro-magnetic theory would not be refracted if the wave-length were comparable with molecular distances. The properties of the longitudinal waves were developed in the paper. Prof. Thompson exhibited a number of photographs which had been taken at the Cavendish Laboratory by Prof. Röntgen's method, and experiments made on the Röntgen rays were described. In one of these experiments the photographic plate was placed inside the vacuum tube so as to intercept the rays between the kathode and the walls of the tube; in this case the plate was not affected, showing that the fluorescence of the glass is necessary for the production of these rays. Other experiments were made to see if they could be excited by fluorescence without a kathode; the ring discharge was produced in bulbs, and caused a vivid phosphorescence; a plate protected by cardboard when exposed to the bulb for an hour was not affected, nor was any greater effect produced when the bulb was filled with a gas such as oxygen, which phosphoresces under the discharge. It thus appears that both a kathode and a phosphorescent substance are required for the production of these rays, and that one without the other is inoperative. A series of experiments were made by taking photographs through tourmaline plates, (1) with their axes parallel, (2) with their axes crossed; it was hoped by this method to get some evidence as to whether the rays were longitudinal or transverse. A considerable number of photographs were taken in this way, but no difference could be detected in the obstruction offered to the rays by the tourmaline plates in the two cases. Another method of investigating the same question was described, based on Elster and Geitel's discovery of the influence of the plane of polarisation of light on its power to discharge electricity from a metallic surface. The experiments, which were not concluded until the day after the meeting of the Society, show that these rays exert the most powerful effect in discharging electricity, whether positive or negative, from an insulated electrified metal plate exposed to their influence. A bulb separated from the charged plate by a board three-quarters of an inch thick covered with several layers of tinfoil exerted a most powerful effect, and it was not until the thickness of the metal between the bulb and the electrified plate was nearly quarter of an inch that the effect ceased to be perceptible. The electrified plate is a much more delicate detector of these rays than the photographic one, and is more suitable when measurements are required. These results, though by no means conclusive, are in favour of the vibrations being longitudinal.

We have already mentioned, in our abstracts of the *Comptes rendus*, and in notes, the many papers which have been read before the Paris Academy descriptive of developments of Röntgen's work. In France, both the chemical and surgical sides of the discovery are being studied. As recorded in our issue of February 6 (p. 324), Prof. Lannelongue, assisted by MM. Barthélemy and Oudin, have demonstrated to the Academy of Sciences the applicability of the discovery to surgery, and observations made by Prof. Lannelongue since then bear out his conclusions that in diseases where there is an actual loss of substance in the bone, or an abnormal growth of bony tissue, photography by means of Röntgen's rays will be a valuable aid to diagnosis. The current number of the *Comptes rendus* contains several papers dealing with the chemical properties of the rays. M. Meslans has studied the influence of the chemical nature of substances on their transparency to the rays. He has found that the varieties of carbon —diamonds, graphite, and charcoal—and their compounds are easily traversed by Röntgen's rays, as also are compounds of hydrogen, oxygen, and nitrogen. Alkaloids are also transparent, but sulphur, iodine, and silicon are opaque. M. Charles Henry has found that by coating coins opaque to the rays with phosphorescent sulphide of zinc, photographic impressions of substances beneath the coins can be obtained, metals coated in this manner appearing to lose their opacity to the Röntgen rays. M. Henry has also found that phosphorescent sulphide of zinc emits, in addition to green light, a large number of the new actinic rays.

The properties of Lenard rays—that is, kathode rays which have travelled outside the tube in which they had been produced—are also being investigated. A note in the *Chemical News* states that Prof. Slaby, of Charlottenburg, has obtained good photographs by means of Lenard rays. Dr. J. Joly has also been successful in this direction of work. At the Dublin University Experimental Science Association, on February 11, he showed photographs of various objects taken after the manner of Röntgen by the Lenard rays. One of a pair of spectacles within its case showed well the transparency of wood and cardboard and the comparative opacity of glass, and the still higher opacity of the heavy metals. Experiments on refraction of the rays have in the case of paraffin oil given no evidence of refraction. This substance proved very transparent. Experiments upon the reflection of the rays have, however, yielded positive results. The rays were reflected by a silvered copper mirror on to a sensitive plate. The plate was in the geometrical shadow of a thick lead shield, the rays passing through a slot in the shield and through thick millboard before reaching the mirror, which was inclined at an angle of about 45° to the plate. Exposures of two hours gave distinct photographic effects. Reflection from a concave mirror placed behind the plate and facing the sensitive film, did not give any trace of a focus, but a darkening of the full diameter of the mirror, and rather more marked at the edge; thus suggesting irregular reflection of the rays. The experiment of Prof. J. J. Thomson on the discharge of a charged electroscope by the rays was also shown by Dr. Joly, and, at the conclusion of the meeting, it was demonstrated that this effect was not obtained at short distances from the tube, the electroscope then becoming positively electrified.

Several important letters on the subject of Röntgen rays have come to us. Lord Blythswood communicates the following, in continuation of his letter published last week:—

"Since I last wrote to you, I, at the suggestion of Lord Kelvin,

placed my sensitive plate in a metal zone with an aluminium window in it. The whole was well earthed. This precaution was taken to prevent any sparking inside the zone. The zone was placed between the poles of my Wimshurst machine, and photographs of various objects taken. This is, I think, conclusive that the influence at work is not the ordinary electrical waves or discharges. For in a carefully-closed metal zone there can be no electrification, neither do the photographs of metal objects show any trace of discharge or sparking."

The following important communication on "Photography through Opaque Bodies without Crookes' Tube" has been received from Dr. John Macintyre:—

"At the demonstration given by Lord Blythswood and Dr. J. T. Bottomley before the Glasgow Philosophical Society on Feb. 5, I was requested to show some results in shadow-photography obtained by the use of comparatively simple apparatus. My remarks were then intended to show that as we became familiar with this new art the apparatus would become less complicated. As the present notes are written for another purpose I simply mention the fact that the experiments noted below were made with the same apparatus exclusive of Crookes' rube. It consisted of an induction coil giving not more than a two-inch spark, the primary coil of which was excited by four small secondary cells giving two volts each; a very small Tesla coil made by Messrs. Baird and Tatlock; and a Crookes' tube selected from the stock of an instrument-maker, but not specially prepared.

"Lord Blythswood on that occasion described the experiments published in the last issue of NATURE by means of which he was able to demonstrate that photographs could be taken without Crookes' tubes. Mr. Sydney D. Rowland in his interesting contribution to the subject in the same issue raises the question of the possibility of a 'contact phenomenon' being the explanation of Mr. Gifford's results, and not Röntgen's rays at all. As the same doubt was suggested to my mind as the result of my own experience I should like to record the following experiments which were made by me with a view of confirming the extremely interesting results recorded by Lord Blythswood. In doing so I wish it clearly understood that I do not suggest that the photographs taken through opaque bodies by Lord Blythswood were not the result of Röntgen's rays; my statements simply bear upon my own experience and the results I have been able to obtain.

"In my first experiment the sensitised paper was enclosed in a mahogany box, the sides of which were three-sixteenths of an inch thick, and the object to be photographed was a perforated zinc plate; bromide paper was substituted for glass plates in order to do away with resistance, and the whole was placed between the terminals of the small Tesla coil. The current coming from the negative pole before reaching the positive had therefore to pass through the following structures: (1) Three-sixteenths of an inch of mahogany, (2) a sheet of aluminium one-sixteenth of an inch thick, (3) the zinc plate, (4) the bromide paper, (5) some black cardboard for packing, (6) the other end of the box, also three-sixteenths of an inch. The box was insulated from the earth and held between the poles for ten minutes. On developing, a distinct image of the plate was obtained, the perforations showing black on the paper, while the part upon which the zinc rested had not been acted upon at all. It was clear from this experiment that I had obtained a photograph without a Crookes tube, and a negative—that is to say, had it been printed from the bromide paper we would have had a reproduction of the original perforated plate.

"The second experiment was different from the first inasmuch as I placed a metal plate behind the bromide paper, and consequently there was the following arrangement proceeding from the negative to the positive pole: (1) The end of the mahogany box, (2) the aluminium plate, (3) the zinc perforated plate, (4) the bromide paper, (5) a copper disc, (6) black cardboard for packing, (7) the other end of the mahogany box. This was again placed between the terminals of the Tesla coil for the same time, and the bromide paper developed in the usual way. This time the perforations did not mark the paper, but I had a distinct impression of the zinc; in other words, I had obtained a positive, because, had I printed a copy, the perforations would have appeared black, quite the reverse of the last experiment.

"It will be observed that in neither case had I, like Mr. Sydney Rowland, connected the positive pole of the coil with the metal plate behind the sensitised surface.

"On submitting these results (which were obtained previous to the date of Mr. Sydney Rowland's letter) to Lord Kelvin and Dr. Bottomley they agreed with me that the picture had possibly not been taken by means of Röntgen's rays at all; and Lord Kelvin suggested the following third experiment, in which the sensitised paper was enclosed in a metal box. In this experiment the following structures were placed in definite order between the negative and positive pole: (1) The front of the mahogany box, (2) several layers of black paper, which formed a covering for the metal box, (3) the front of the metal box, (4) the zinc perforated plate, (5) the bromide paper, (6) the metal plate, (7) the back of the metal box, (8) the black paper surrounding the metal box, (9) the other end of the mahogany box.

"It will be noticed that in this experiment the metal plates in front and behind the bromide paper were enclosed in a metal case which attracted the current round it. The result was as we had anticipated, because repeated attempts with different and prolonged exposures failed to produce any impression whatever upon the bromide paper.

"Had the photographs been obtained by the X-rays, one might have expected that while the current was conducted past the sensitised paper some impression would have been got by the Röntgen's rays piercing the metal box. As yet, however, I have not been able to obtain this result, although I have tried to with thin aluminium sheets in contact with each other at the edges and enclosing the metal plates and bromide paper.

"I should like to point out that Lord Blythswood's experiments differ from the above in many respects. He used glass sensitised plates; the apparatus was exceedingly powerful; and the objects were not placed between the terminals of the machine, but at some distance below the line of the sparks.

"From the above-mentioned experiments it is clear (1) that photographs may be taken without Crookes' tubes; (2) that different results may be obtained according to the conditions to which the sensitised surface is subjected. And I would suggest the following questions as suitable for further investigation:—(*a*) Are they not the result of a force different from the Röntgen's rays? (*b*) what is this force which is now described as a 'contact phenomenon'—a term, of course, which does not explain the actinic power? (*c*) what is the actinic power which we have hitherto considered to be a property of ordinary light? (*d*) were Röntgen's rays not generated between the metal plates?

"There is one point in this experiment which has not been touched upon by other writers, and which I should like to allude to in conclusion. It is quite clear, whether the photographs produced without Crookes' tubes were obtained by means of Röntgen's rays or not, that a current may be conducted through metal plates to a sensitised surface and impressions obtained thereon. In Mr. Sydney's Rowland's letter he makes no mention of metal plates having been placed in front of the sensitised plates. I have placed three plates of different metals in front of the object to be photographed during the time of exposure and obtained a picture, so that we have here a method of photographing certain objects through opaque bodies in the form of metal plates, and, theoretically speaking, the thickness would be a matter of comparatively little importance."

Prof. J. Wertheimer, Principal of the Merchant Venturers' Technical College, Bristol, has, at the suggestion of Mr. C. A. Morton, Surgeon to the Bristol General Hospital, taken a radiogram of an amputated foot into which Mr. Morton had introduced nine foreign bodies (bullets, splinters of needles, and glass wedges). Six of these were plainly seen on the radiogram, although Mr. Morton found that a fellow-surgeon could only locate one by palpation.

Prof. Wertheimer says: "Two points of interest arise on examination of the radiogram. Mr. Morton had endeavoured to place a fragment of needle through the last joint of the great toe on its plantar aspect. On dissecting the foot, after the radiogram had been taken, he found that the fragment had penetrated the inner corner of the distal end of the first phalanx, and had passed *beneath* the bone, leaving a small portion embedded in the phalanx itself. This fragment shows up plainly in the radiogram, and, as the foot rested on its plantar aspect, the rays must have passed through the whole thickness of the bone. The radiogram does not, however, show that the needle is *beneath* the bone. It appears, therefore, that in such cases two radiograms will be needed—one taken with the dorsal, and the other with the plantar aspect uppermost, the conditions being other-

wise precisely alike. A comparison of these should show whether the foreign object is nearer the dorsal or the plantar aspect of the foot.

"The second point refers to the three objects not seen clearly in the radiogram. The tube used was the ordinary 'shadow of the cross' one, and, though the cross was bent back, the shadow of its supports was visible; two of the objects were directly under this shadow. The third lay parallel and very close to a bone, and hence is not plainly distinguishable."

Photographs have been obtained by utilising other sources of luminosity than high vacuum tubes. The following experiments, performed by Messrs. Wm. Wallace and H. C. Pocklington in the Physical Laboratory of the Leeds Central Higher Grade School, are of interest:—

"A cheap German incandescent lamp of low candle-power was used in place of a Crookes' tube, a piece of tinfoil applied to the outside serving as one electrode, and the filament as the other. The current employed was the high frequency one obtained from a Tesla coil actuated by a large Ruhmkorff. The sparking distance of the Tesla was about 5/8 inch. This apparatus gave a vivid green phosphorescence of the glass, which soon grew less, and in fifteen minutes had almost disappeared. Three exposures were made in succession, each of fifteen minutes: the first when the lamp was new; the second immediately afterwards, the lamp being tired by the previous exposure; for the third, the tinfoil electrode was shifted round about 90°, so as to utilise a fresh part of the surface of the glass. The three negatives were developed simultaneously; the first was good, the other two were under-exposed to about the same extent. In the last experiment, the green phosphorescence, though not as brilliant as in the first, was much more brilliant than in the second. This seems to show that the production of X-rays is due to some cause different from that which produces the phosphorescence."

Mr. J. W. Gifford has obtained photographs by Röntgen's methods, and also by means of the ordinary discharge of an induction coil. Replying to a suggestion that results obtained by him with metal discs were due to a "contact" phenomenon, and not to Röntgen's rays, he says:—

"I notice in your issue of February 13, p. 340, that Mr. Sydney D. Rowland thinks that he has evidence to prove that my results without a Crookes' tube were not due to the 'Röntgen rays.' I have already replied to his observations elsewhere (*British Medical Journal*); but will you allow me to say that I think the evidence he advances entirely turns on whether the electrograph was a shadow or an impression, or, in other words, whether surface markings of the objects electrographed were reproduced, or not. Now, the discs I used bore numbers stamped on them, but in no case were these numbers, or any surface markings whatever, to be found in the resulting negative, a print of which I enclose.

"With regard to what Mr. Rowland says about the objects, in his case, being behind or in front of the film, I would suggest that the discharge from a coil is an oscillatory one, and that glass is fairly transparent to the 'Röntgen rays,' almost as transparent as aluminium, in fact. But conditions are often so different, that I do not feel justified in criticising another man's work without having seen his experiments myself. I must, however, most emphatically disclaim any positive assertions in the present stage of the inquiry. I have, as far as I am aware, only mentioned tentatively what seem to me the general indications of my experiments up to now, and feel that in investigations of this kind the balance is generally in favour of one's first impressions being wrong.

"I do not know if you have observed that when Crookes' tubes are employed for the purpose, after about an hour's use they become coated, both above and below, with a thin layer of dust. This happens, at least, time after time in my own laboratory."

Mr. W. A. D. Rudge, writing from the Science, Art and Technical Schools, Plymouth, says that he has obtained a radiogram of a crayfish, and found the exoskeleton to be as transparent to the new radiations as glass and aluminium.

Our United States correspondent sends us descriptions of work being done in America, in continuation of Röntgen's discovery. He says very successful photographs have now been obtained by Prof. A. W. Wright, of Yale. Prof. Wright has photographed a piece of metal having a fracture which had been welded, but showed no flaw or line of puncture to the eye. The photograph, however, revealed the fracture. This last result was considered by ordnance officials of the Government to be of profound significance, as indicating a means of testing armour for hidden defects and discovering hidden flaws in machinery. Prof. John Trowbridge, of Cambridge, Mass., has also obtained some results. He arranged strips of glass an eighth-inch thick in a wooden box of inch board, and passed the rays through the board, thus obtaining a photograph of the strips of glass. By passing the rays through prisms of wood and of vulcanite he has confirmed the observation that they were not refracted.

THE MANUFACTURE OF ALUMINIUM BY ELECTROLYSIS.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, February 11, a paper was read on "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alfred E. Hunt. The author's description of the ores of aluminium best fitted for electrolytic reduction to the metallic state, and of the general principles governing the extraction of the metal from its compounds, makes interesting reading.

The Hall process, which is that adopted by the Pittsburg Reduction Company, involves the direct electrolysis of the sesquioxide, alumina, dissolved in a molten bath of the mixed fluorides of aluminium, calcium and sodium. One cubic foot of the solvent serves for an hourly production of one pound of metallic aluminium, the bath used being capable of dissolving one-third of its own weight of alumina. The electrical energy required for extracting this amount of metal is 3730 watt-hours for the decomposition of the alumina, with a further supply to maintain the bath at the temperature necessary for the molten condition. The fluorides remain unchanged, so that the operation is continuous. The bath is made either from a mixture of fluorspar and cryolite, or from the artificial fluorides; and it may be fused in a separate vessel when starting work, or in the bath by the current itself. Alumina is added at frequent intervals to prevent too great a variation in the resistance of the bath, and the aluminium, as it is produced, is siphoned from beneath the layer of fluoride, where it collected, without interference with the progress of the operations. The oxygen of the alumina is liberated at the carbon anode, which, at the temperature of the bath (980° C.) oxidises to carbon monoxide. Outside the bath this is burnt at once to carbon dioxide, and is allowed to escape into the working apartment. The carbon anodes are consumed at nearly the same rate as the aluminium is produced, the amount being about two-thirds of the quantity actually used. The difference of potentials theoretically necessary for the separation of the constituents of alumina is about 2·8 volts, but a greater difference is due to the resistance of the bath. The pots employed are of iron with carbon linings, but these can be dispensed with if a high degree of purity is not required.

The chief impurities in the finished product are silicon and iron. These are derived from the alumina as well as from the carbon anodes. Aluminium can be produced containing 99¾ per cent. of the pure metal, and is regularly delivered with 99 per cent. The electrolytic baths are joined in series, the positive bar of the switch-board being joined to the carbon anode of one of the baths, and the last pot of the series being joined to the negative board of the switch-board. All the copper connections are necessarily very heavy, on account of the large currents employed.

The electrical energy is generated at the works of the Niagara Falls Power Company, and is conveyed, without the intervention of transformers, over a distance of about half a mile, by stranded copper cables 1¼ inches in diameter. The loss in transmission is about 1½ per cent. of the energy conveyed.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. D. H. Nagel, Fellow of Trinity College, has been elected as a Delegate of Local Examinations in place of Mr. E. Chapman, Fellow of Magdalen College, resigned.

Mr. F. T. Richards, Fellow of Trinity College, has been re-elected a Curator of the Botanic Garden.

Mr. J. E. Marsh, M.A., Balliol College, has been reappointed Lecturer in Materia Medica and Pharmacology for the year 1896.

Cambridge.—Mr. J. E. Marr, F.R.S., Fellow of St. John's College, has been reappointed University Lecturer in Geology for five years.

The Council of the Senate propose to submit a grace for the appointment of a syndicate to consider what further rights or privileges (if any) should be granted to women students by the University, and in particular whether they should be admissible to degrees.

The Special Board for Biology propose that the arrangement subsisting for the last twenty years between the University and the Zoological Station at Naples should be renewed for a further period of five years. This arrangement secures for University students the use of a table in the laboratory and facilities for research, in consideration of an annual payment to Dr. Dohrn of £100 from the Worts Travelling Scholars Fund.

The Board of Agriculture has made a grant of £650 to the Glasgow and West of Scotland Technical College. The same amount was granted to the College last year.

In Paris the Société de Topographie is making an effort to establish topography as an ordinary subject of instruction, and has published a circular and syllabus for the purpose.

The Russian Government has, says the *British Medical Journal*, assigned an annual grant, equivalent to about £10,000, to the Medical School for Women in St. Petersburg. The city undertakes to provide £2400, and private munificence has raised an endowment fund of £70,000. Preliminary courses are already being given.

The following are among recent appointments abroad: Dr. Eigenbrodt to be Extraordinary Professor of Surgery at Leipzig; Dr. Lenhossék to be Extraordinary Professor of Anatomy at Tubingen; Dr. M. Valsilieff to be Extraordinary Professor of Theoretical Surgery at Warsaw; Dr. Eliza M. Mosher to be Professor of Hygiene in the University of Michigan.

The following announcements are made in *Science*:—Mr. Joseph Bannigan has given 4000 dols. to the Catholic University of America, and has made known his intention to donate for twelve years 4000 dols. a year for library purposes. By the will of the late Mrs. Doyon, the University of Wisconsin has received 5000 dols., the income of which is to be devoted to scholarships for young women. Two scholarships of 2000 dols. each have been presented to Tufts College, one by Mrs. A. B. Perkins, and the other by J. S. and H. N. White.

The disasters of the late war seem to be teaching the Chinese that the traditional attitude of distrust and exclusion of Western civilisation cannot any longer be safely maintained. It may be taken as a sign of the times that the Vice-Regent of Tientsin has entertained a proposal to start a university upon the European model. The university is particularly intended to foster the technical sciences, and will be connected with a preparatory school. Mr. Charles D. Jenney will undertake its direction, and the staff will be partly composed of foreigners. The autumn of this year is to see the opening of the school and university.

The Apprentices' Institution has recently instituted inquiries among a large number of trade societies and workmen's clubs with a view to ascertaining the opinion of working men themselves upon the apprenticeship system. From the standpoint of the advocates of technical education, the results of their enquiry are very satisfactory. A unanimous affirmative was given by all the trades to the questions—Is your Society of opinion that instruction for a number of years in the workshop is essential to the trained mechanic? But especially valuable and significant is the emphatic "No" to the question—Is your Society of opinion that the instruction afforded in the technical schools is sufficient training for a skilled mechanic with apprenticeship? Asked what they think, whether the instruction in technical schools should be given during apprenticeship or before it, the answer was in the large majority of cases "during apprenticeship." Putting side by side with this the remark of Mr. Reynolds, of Manchester, the Chairman of the Directors, and Organising Secretaries for Technical and Secondary Education, at their recent meeting, that the great difficulty the technical schools had to contend with was the want of preparation exhibited by the pupils who present themselves for instruction in the technical schools, it becomes abundantly manifest what policy ought to be pursued by the Technical Instruction Committees throughout the country.

As we recorded in our issue of February 14, 1895, the County Council of Hampshire resolved to devote £6000 of the surplus of the funds available for technical education during the preceding year to general purposes in the county. It would seem that they are not to be deterred from their retrograde policy by the unanimous protests of the various educational papers, for at the quarterly meeting of the Council, held on the 10th inst., a motion was proposed by the Chairman of the Finance Committee—"That the Finance and Technical Education Committees be instructed to meet together and report to the meeting in May 1896, their opinion upon the manner in which the balance remaining after the annual expenditure on technical education has been defrayed, shall be dealt with." It appears that, notwithstanding the transfer of £6000 from the technical education account towards the cost of the county buildings, up to December 31 last, and taking the estimate to the end of March next, there would be a balance of £12,000. Though the Chairman of the Technical Instruction Committee assured the Council there was no prospect of having a large balance to deal with in the future, evidently meaning that the Committee had every need of this money which they were reserving, the motion was put and carried. It would be supposed from an action such as this, that Hampshire is already well supplied with every kind of secondary education; but is it so? At Southampton, which it is true receives *its share* of the whole grant, there are at least two institutions which are in want of assistance. The Hartley Institution, which receives a county grant of only £75 per annum, is badly crippled for want of funds. The Grammar School similarly is greatly in want of help to develop the technical side of its work, and the same condition of things is true in many other of the local centres. In addition to all this, one hears repeatedly of the urgent need of Schools of Forestry in this country, and yet Hampshire, with the New Forest in its midst, has £12,000 for which it has no educational use!

Particulars are tabulated in the *Technical Education Gazette* of the principal scholarships which are awarded in London, giving free education or education at reduced fees—(1) at the public secondary schools; (2) at universities, university colleges, polytechnics, technical institutes, and other places of higher education; (3) at schools of art. The tables are intended to give some idea as to the opportunities that are offered to the inhabitants of London of obtaining education above the elementary grade, either entirely free or at greatly reduced cost. The total number of scholarships tenable at public secondary schools appear to be as follows: Boys—1240 per annum (of which all except 85 may be regarded as actually available for pupils in public elementary schools). Girls—543 per annum (of which all except 8 may be regarded as actually available for pupils in public elementary schools). Total—1783 per annum (of which as many as 1690 are actually available for pupils in public elementary schools). Taking the average number in attendance in public elementary schools (exclusive of infants) as 382,121, it is found that the number of scholarships available per 1000 children in attendance is 4·4, of which 1·5 per 1000 children are provided by the Technical Education Board of the London County Council. The majority of the scholarships tenable at universities, university colleges, polytechnics, and similar institutions, are restricted as regards the school previously attended, but unrestricted so far as residence is concerned, though some are confined to residents within the county of London. No notice is taken of the numerous scholarships and exhibitions offered by university authorities outside London, such as the colleges of Oxford or Cambridge, but an attempt is made to show the facilities for acquiring training of a university type offered to pupils who are educated or who reside in London. The table shows that the scholarships available in London for giving training of a university type are as follows: open to young men only, 240; open to young men or young women, 120; open to young women only, 40; making a total of 400. These scholarships do not include, however, those that are specially awarded by the City Companies.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xviii. No. 1, January, 1896.—"Sur la réduction à sa forme canonique de la structure d'un groupe de transformations fini et continu," by E. Cartan. This memoir occupies 61 pages. We state the most important results in the writer's own words: "On peut toujours par des

opérations *rationnelles* ramener le problème au cas où le groupe est *semi-simple*, et même reconnaître d'avance la *nature* des sous-groupes invariants simples qui *composent* le groupe. . . . Quant à la réduction à sa forme canonique de la structure d'un groupe simple, elle dépend d'une certaine équation algébrique dont le *groupe* de substitutions, au sens de Galois, est connu ; cette équation s'appelle *l'équation caractéristique* du groupe. Les différents groupes de substitutions qui s'introduisent ainsi ne présentent rien d'interessant et se relient immediatement aux groupes symétriques de n lettres. Néanmoins trois d'entre eux offrent un intérêt particulier et sont isomorphes, l'un avec *le groupe des* 27 *droites d'une surface du* 3^e^ *ordre*, l'autre avec *le groupe des* 28 *tangentes doubles d'une courbe du* 4^e^ *ordre*, le dernier avec le 7^e^ *groupe hypoabélien de* 120 *lettres*. Ce n'est pas un des résultats les moins intéressants et les moins inattendus de cette étude, que d'établir une relation entre ces groupes de substitutions de Galois et les groupes de transformations de M. Lie."—Mr. A. L. Baker writes upon algebraic symbols. The symbols considered are $+, -, i(\sqrt{-1})$, and $-i$. The closing sentences will indicate the line of reasoning. "In tri-dimensional domains we have $(\sqrt{-})^{\infty}x = x + iy + jv + ku$, a quaternion. Is this a hint that in the Calculus of Reals, Complex Functions and Quaternions, we have run the gamut of the Algebraic Calculi?" There is some (to us) novel notation in this article. To express the roots of the Solvable Quantics as symmetrical functions of homologues, is the title of an interesting algebraic article by C. H. Kummell. There is, it may be inferred, some stiff reading in these three articles.—Two short notes on singular solutions by J. M. Page, and on a point of the theory of functions by A. S. Chessin, close the number, which is adorned with a fine portrait of the French mathematician, M. Paul Appell.

Bulletin of the Mathematical Society, vol. ii. No. 4, January.—On the convergence of the series used in the subject of perturbations, by Dr. G. W. Hill. M. Poincaré ("Les Méthodes nouvelles de la Mécanique céleste") has recently insisted that certain series, in this subject, under a certain condition, are, in the rigorous mathematical sense, divergent. Dr. Hill thinks that the reasons brought forward to sustain this opinion are scarcely convincing, and so, without attempting to find a flaw in M. Poincaré's logic, he aims at pointing out a class of cases where the convergency can be shown in spite of the incommensurability of the component arguments.—Mr. R. A. Roberts contributes an article on the locus of the foci of conics having double contact with two fixed conics.—Note on the common tangents of two similar cycloidal curves, by Prof. F. Morley. This is the application of a new method, given by the writer in vols. xv. and xvi. of the *American Journal of Mathematics*, to a question proposed by Prof. Aiyar, in the *Educational Times* for November 1895.—The list of new publications is an extended one, and the notes, as usual, are of interest. There is, however, an error in the quotation from our pages. On p. 651 (vol. lii.) is given a list of names proposed for the Council of the London Mathematical Society, and at the end of the note it is stated that Mr. Jenkins and the late G. C. De Morgan were elected joint secretaries (in January 1866). The *Bulletin* says, "the late Prof. De Morgan." It is a matter of common knowledge that Prof. *Augustus* De Morgan was the first President. The Secretary was his son.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 23.—"An Attempt to Determine the Condition in which Helium and the Associated Gases exist in Minerals." By Prof. W. A. Tilden, F.R.S.

From the results of the experiments recorded in this paper, it seems that helium exists in the minerals in which it is found in a condition comparable with that in which hydrogen is associated with many metals, and carbonic oxide especially with iron. Whether this condition is rightly distinguished from ordinary chemical combination is a question which admits of debate. The stability of all dissociable compounds is influenced by pressure and by temperature in the same kind of way as "occlusion," which, like ordinary chemical combination again, is a phenomenon in which the bodies concerned exercise a power of selection.

The presence of hydrogen as well as carbon dioxide in granite, if already observed, is not known to geologists generally. From observation on variations in the critical point of carbon dioxide in minerals (*Journ. Chem. Soc.*, 1876, ii. 248), Hartley seems to infer that the incondensable gas present with carbon dioxide, is usually nitrogen. A passage in Geikie's "Text-Book of Geology," third edition, p. 110, refers to the presence of hydrogen in cavities ; but no information is given as to the evidence upon which this statement is based. The presence of hydrogen in such a rock as granite must be attributed to the existence of this gas in large proportion in the atmosphere in which the rock was crystallised. Whether this was the primeval atmosphere of the earth before the hydrogen had escaped or had been oxidised into water, or whether it resulted from the local action of water upon unoxidised metals or other materials in the interior of the earth, is a question which may be of some interest to the geologist. If the former hypothesis were adopted, it would perhaps be difficult to explain the absence of helium from the gas included in the rock ; and, on the whole, the latter view appears to afford the more probable explanation.

Experiments show that hydrogen is present in even larger proportion in the granite from the neighbourhood of Dublin, and it is proposed to examine some other examples of the ancient crystalline rocks in order to determine the nature of the gases enclosed in them.

Physical Society, February 14.—Annual General Meeting.—Captain W. de W. Abney, President, in the chair.—The Chairman, after referring to the position of the Society, called upon the Treasurer to read the balance-sheet. After a discussion on the financial status of the Society, in which a number of members took part, the ballot was held for the election of a President and Council for the ensuing year. The following gentlemen were declared duly elected: President—Captain W. de W. Abney, C.B., F.R.S. Vice-Presidents—Shelford Bidwell, F.R.S. ; Major-General E. R. Festing, F.R.S. ; Prof. J. Perry, F.R.S. ; G. Johnstone Stoney, F.R.S. Secretaries—T. H. Blakesley, 3 Eliot Hill, Lewisham, S.E. ; and H. M. Elder, 50 City Road, E.C. Treasurer—Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey. Demonstrator—C. Vernon Boys, F.R.S. Other members of Council—Walter Baily, Dr. C. V. Burton; L. Fletcher, F.R.S.; R. T. Glazebrook, F.R.S. ; Prof. A. Gray, G. Griffith, Prof. G. M. Minchin, F.R.S. ; Prof. W. Ramsay, F.R.S. ; Prof. S. P. Thompson, F.R.S. ; and Prof. S. Young, F.R.S.—The Chairman read an obituary notice of the late Right Hon. T. H. Huxley.—A vote of thanks to the auditors was proposed by Prof. Carey Foster, seconded by Mr. Enright, and carried unanimously. A vote of thanks to the officers was proposed by Prof. A. Gray, seconded by Mr. Rhodes, and carried unanimously. A vote of thanks to the Chemical Society for the use of their rooms, was proposed by the Chairman, and carried by acclamation.—The meeting was then resolved into an ordinary science meeting, and a paper, on the determination of high temperatures by the meldometer, by Prof. Ramsay and Mr. Eumorfopoulos, was read by the latter. The meldometer—an instrument invented by Dr. Joly, of Dublin—consists essentially of a thin platinum strip which can be heated by the passage of an electric current. Small fragments of a solid substance are placed on the platinum strip, and the temperature at which they melt is deduced from the length of the platinum strip, which has been previously calibrated by means of solids of known melting-point. The authors have used gold for the purpose of calibrating the strip, and have assumed Violle's value, 1045° C., for the melting-point of gold. A number of measurements have been made of the melting-point of salts of sodium, lithium, strontium, barium, calcium, and lead. The results obtained, however, differ considerably from those of Heycock and Neville, and the authors have not been able to account for these differences. Prof. Ramsay said the chief advantage of the meldometer was that only a very minute fragment of the substance was required for the measurement, so that extreme purity of the sample could be secured. There was the disadvantage, however, that many substances undergo some change when heated in air. In reply to a question from Mr. Blakesley, Prof. Ramsay said that the property of the platinum which was used to measure the temperature was its expansion. Mr. Campbell asked whether the zero of the instrument was found to be constant. In Cardew voltmeters it often took several hours for the needle to come back to zero after heating. Mr. Eumorfopoulos, in reply, said that the zero was constant to within a quarter of a degree.—Prof. Ramsay also exhibited a small direct-vision spectroscope, in which the eye-piece is moved

in a plane perpendicular to the axis of the instrument by means of a micrometer screw. This form of spectroscope was found to be of great utility in verifying the position of lines in the spectrum.

Geological Society, London, February 5.—Dr. Henry Woodward, F.R.S., President in the chair.—On the Morte Slates and Associated Beds in North Devon and West Somerset.—Part 1, by Dr. Henry Hicks, F.R.S. In a paper read before the Society in 1890 the author stated that he had found the Morte Slates to be fossiliferous, and had come to the conclusion that they were the oldest rocks in the North Devon area and had been thrust over much newer rocks, producing a deceptive appearance of conformity; and that there was not a continuous upward succession in the rocks from the Bristol Channel to the neighbourhood of Barnstaple. Since that paper was read, the author has obtained much additional evidence bearing on the succession, which was described so far as the position and age of the Morte Slates in the Ilfracombe area are concerned.—Evidences of glacial action in Australia in Permo-Carboniferous Time, by Prof. T. W. Edgeworth David. The author, after summarising the work of previous observers, gave an account of recent observations made by himself. In Hallett's Cove, near Adelaide, the pre-Cambrian rocks were strongly glaciated, striæ being seen when the overlying glacial beds are removed, as sharply cut as though caused by recent glacial action, and trending nearly north and south, the ice having come from the south. The overlying glacial beds were in places fairly stratified, while parts contain abundance of well-striated boulders; these beds are from 23 to over 100 feet thick. Proofs were obtained that in this case the glaciation occurred in an age intermediate between Miocene and pre-Cambrian, and probably did not antedate the close of the Palæozoic period. In Wild Duck Creek, near Heathcote, Lower Silurian (Ordovician) beds exhibited strongly-grooved, polished surfaces, the grooves being from S. 5° E. to N. 5° W., the ice having probably come from the south. They were succeeded by Permo-Carboniferous glacial beds, consisting chiefly of mudstones with well-glaciated boulders. At Bacchus Marsh Ordovician beds were also well-striated and polished, and more or less *moutonnés*. There also the ice came from a southerly point. These beds were succeeded by Permo-Carboniferous glacial beds having an approximate thickness of at least 2000 feet, consisting of mudstones with well-glaciated boulders. It was extremely probable that the glacial beds of Bacchus Marsh, Wild Duck Creek, and Springhurst in Victoria were of homotaxial if not contemporaneous origin, and they may probably be correlated with the glacial conglomerates at Mount Reid in Tasmania, these correlations being mainly based on lithological evidence.

CAMBRIDGE.

Philosophical Society, January 27.—Prof. Liveing, Vice-President, in the chair.—On longitudinal vibrations in connection with recent photographic discoveries, by Prof. J. J. Thomson (see p. 379).—On the equilibrium of isotropic elastic solid shells of nearly spherical form, by Dr. Chree. Attention was chiefly devoted to the case of a thin shell exposed to uniform, but different, normal pressures over its two surfaces. The effect of external pressure, it was proved, is to increase, while that of internal pressure is to diminish the original departure from sphericity.—A harmonic analysis of the amount of solar radiation received at the different latitudes on the earth's surface, by Mr. R. Hargreaves. The amount of solar radiation falling on the earth's surface in any latitude is expressed by a harmonic series containing constant, annual, semi-annual terms, and so forth. The dependence of the coefficients on latitude, and also on the astronomical elements obliquity of the ecliptic, eccentricity, and longitude of perihelion, was fully discussed. Numerical results were given in connection with each point, showing the extent to which the present values may be modified by such secular changes as are known to astronomers; and complete numerical data are thus provided for the discussion of the question whether these astronomical changes are a *vera causa* in the explanation of changes of climate.

EDINBURGH.

Royal Society, January 20.—Rev. Prof. Flint in the chair.—Dr. Buchan read a paper on the recent great atmospheric pressure. So far, the highest reading had been that recorded at Ochtertyre, in Perthshire, where 31·107 inches was registered on the 9th. This place, curiously enough, had the "record" for low readings, a pressure of 27·333 inches having been recorded there in January 1884. This was the lowest ever recorded anywhere.—Prof. Crum Brown showed and discussed an experiment illustrating the modern theory of salt solutions.—Dr. A. Lockhart Gillespie gave statistics from the Infirmary records of the past fifty years, illustrating the relations of weather, influenza, and disease. Diseases of the respiratory system were more common during cyclonic weather, and cardiac troubles showed a marked increase after epidemics of influenza. The idea that influenza was more severe than it used to be was not borne out by facts.—Dr. John Murray and Mr. Robert Irvine contributed a paper, replying to criticism, on the chemical changes in marine deposits.—Prof. Tait illustrated the looped, concave-upward path of a rotating spherical projectile by means of a spherical india-rubber balloon.

January 27.—Prof. McKendrick in the chair.—By request of the Council, Mr. Frederick Ives, of Philadelphia, gave an address on the stereo-photochromoscope. The essential features of Mr. Ives' method are as follows. By means of a specially constructed stereoscopic camera, three pairs of negatives are taken at once. Each pair, by a suitable intervention of colour-filters, secures those parts of the object from which one of the Young-Helmholtz three primary colours is reflected. When the six positives are subjected to the synthetic action of the photochromoscope, a coloured, solid-looking, optical illusion is the result. Not the least interesting feature of the process, as was remarked at the meeting, is the light which it throws on the Young-Helmholtz theory of colour vision.

February 3.—Prof. Chrystal in the chair.—Prof. Tait read an obituary notice of Prof. Blackie by the Rev. Dr. Walter Smith.—Dr. W. W. J. Nicoll described experiments he had carried out on the behaviour of the iodine molecule in solution. His method was different from any yet tried, viz. the determination of the molecular volume of the iodine in different solutions, and his results agreed well with those of others approaching the problem from different sides. He found that the value of the iodine molecule in solution was about 85, and this whether it was of the form I_2 or I_4. His conclusion was that the molecules, in the gaseous form, and in dilute solution, were truly comparable.—In Dr. E. H. Barton's absence, Prof. Tait read a paper on the temperature-variation of the magnetic permeability of magnetite. His results, as exhibited graphically, showed that the permeability reached its maximum about 300°, suffered a very sudden decrease about 500°, and remained constant afterwards.—Prof. Tait gave a note on centrobaric shells. Thomson and Tait prove the proposition that a shell, whose density is inversely as the cube of the distance from an internal point, has a true centre of gravity, by considering the forces of attraction. Prof. Tait gave a demonstration of a very much simpler and shorter proof, which had since occurred to him, from the point of view of potential.

PARIS.

Academy of Sciences, February 10.—A study of uranium carbide, by M. H. Moissan.—Action of high frequency currents upon bacterial toxines, by MM. d'Arsonval and Charrin. In these experiments especial care was taken to eliminate, as far as possible, all electrolytic action of a chemical nature. Two different cultures were used (pyocyanic and diphtheric toxines), and in both cases these were found to have their virulence diminished after passage of the high frequency current. It was also noticed that this attenuated virus more or less protected the animals against further injections of the original virus.—On the application of the Röntgen rays to surgical diagnosis, by MM. Lannelongue and Oudin. An application to some diseases of the knee and thigh. The conclusion is drawn that although the application of the new light to surgery has not led to the discovery of any points previously unnoticed, yet it has in all the experiments given results in agreement with the clinical diagnosis.—Microbial associations and tuberculous suppurations, by MM. Lannelongue and Achard. A discussion of the conditions under which other microbes are associated with the tubercle bacillus.—On the structure of Mount Joly, near Saint-Gervais, by MM. Marcel Bertrand and E. Ritter. The view previously held about this mountain, that it had escaped the violent actions to which the neighbouring rocks had been subjected, and that foldings had not taken place, is shown to be untenable. This spot is, in fact, the region where the displacements of the strata have been pushed to the greatest extent.—On campholide, the reduction product from camphoric anhydride, by M. A. Haller. Camphoric anhydride reduced

with sodium amalgam in acid solutions gives the lactone campholide, $C_{10}H_{16}O_2$, not identical with the substance of the same composition obtained by Dr. M. O. Foster (*J. C. S.*, January 1896).—Copernicus and the geographical discoveries of his time, by M. Daubrée.—On the equation of the tides, by M. Maurice d'Ocagne. — On surfaces of lines of spherical curvature, by M. E. Blutel.—On a generalisation of the formula for the area of a spherical triangle, by M. X. Stouff.—Note on the resistance of beams, by M. Paul Toulon.—Method of measuring double refraction in monochromatic light, by M. R. Dongier.—Influence of the chemical nature of substances on their transparency to the Röntgen rays, by M. Maurice Meslans. Compounds of carbon, hydrogen, oxygen, and nitrogen are very nearly transparent for these rays, but the introduction of phosphorus, sulphur, or the halogens (especially iodine) largely increases their opacity.—Application of the method of M. Röntgen, by M. A. Londe. The dark and light parts of a photographic negative are equally transparent to the rays.—Increase of the photographic effect of the Röntgen rays by phosphorescent zinc sulphide, by M. C. Henry. It was found that by coating coins opaque to the rays with phosphorescent sulphide of zinc, photographic impressions of substances beneath the coins could be obtained, metals coated in this manner appearing to lose their opacity to the Röntgen rays.—Photographs obtained by means of the X-rays, by M. C. V. Zenger.—On a mechanical action proceeding from a Crookes' tube, analogous to the photogenic action discovered by Röntgen, by MM. Gossart and Chevallier. In attempting to show the heating effect of a Crookes' tube by means of a radiometer, it was found that the latter, instead of rotating, took up a fixed position under the control of the tube. If the radiometer arms were set in motion by heat, oscillations about this fixed direction ensued, which were the more rapid the smaller the distance between the tube and the radiometer. This force was stopped by the same media as the X-rays.—On the silicide of copper, by M. Vigouroux. Silicon and copper, heated in the electric furnace, give homogeneous products which may contain silicon up to 15 per cent. Prolonged heating at a temperature sufficiently high to drive off excess of copper, leaves the definite compound $SiCu_2$.—On the bromide and chlorobromide of thionyl, by M. A. Besson. Dry HBr, acting on $SOCl_2$ at its boiling-point, gives rise to a mixture from which SOClBr, $SOBr_2$, and S_2Br_2, which can be separated by fractional distillation under reduced pressure. Thionyl bromide is not formed by the action of sulphur dioxide upon phosphorus pentabromide.—On a crystallised sulpho-phosphide of tin, by M. A. Granger. Tin sulphide, acted upon by phosphorus vapour, gives the compound SnP. 2SnS.—Oxyiodides of zinc, by M. Tassily.—Method for determining the purity of butter by means of the density, by M. R. Brullé.—Retineal stroboscopy, by M. Aug. Charpentier.—The expulsion of blood as a means of defence in some Sauterelles, by M. E. Cuénot.—On the frontal expansion of some insects of the family of the Muscides, by M. J. K. d'Herbulais. A criticism of a note on a recent communication on the same subject by M. A. Labboulbène.—On the signification of the fertilisation in the Uredineæ, by M. Sappin-Trouffy.—On the sugars produced in leaves, by M. G. Bonnier. It is shown that in many cases these sweet liquids are directly exuded from the stomata of the leaf, and are not always of animal origin. The rate of production of this vegetable honey is at a maximum during the night.—*Mucor* and *Trichoderma*, by M. J. Ray. Reply to a criticism of M. Paul Vuillemin.—The Hippurite bearing layers in the Valley of the Rhône, by M. H. Douville.—On the existence of numerous Radiolaria in the Ardèche, by M. L. Cayeux.—On the mode of formation of the auriferous minerals of the Witwatersrand in the Transvaal, by M. L. de Launay. The hypothesis of a chemical precipitation of the gold and pyrites during the actual sedimentation is shown to be the most probable.—On a hypothetical mode of formation of the auriferous conglomerates of the Transvaal, by M. E. Cumenge.—On some new and rare forms of calcite at Couzon (Rhône), by M. F. Gonnard.—On the high atmospheric pressures during the month of January 1896, by M. P. Dechevrens.

BERLIN.

Physical Society, January 17.—Prof. du Bois Reymond, President, in the chair.—Dr. Frölich spoke on the protection of physical laboratories from the effects due to electric tram-lines, and described the arrangement used by Siemens and Halske. This consists of two coils of wire-netting at right angles to each other, which being stretched round a wooden frame, and surrounding the instrument it is desired to protect, are put into metallic contact by a cable with the conducting rail of the tram-line. The disturbance due to the passage of a car is thus compensated, and the effect on a magnetised needle is reduced to a small percentage.

January 31.—Prof. du Bois Reymond, President, in the chair.—Dr. Kaufmann gave an elaborate demonstration of Röntgen's X-rays. He also exhibited a very striking photograph of a mouse, which showed in detail the separate vertebræ of the tail, the ribs, and other bones.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Chemistry for Engineers and Manufacturers: B. Blount and A. G. Bloxam, Vol. 1 (Griffin).—A New Natural Theology based upon the Doctrine of Evolution: Rev. J. Morris (Rivington).—Universal Electrical Directory (Alabaster).—Geology: C. L. Barnes (Rivington).—Life and Exploits of Alexander the Great: Dr. E. A. W. Budge (Clay).—Grundriss der Krystallographie für Studirende und zum Selbstunterricht: Dr. G. Linck (Jena, Fischer).—Traité des Matières Colorantes: L. Lefèvre, 2 Vols. (Paris, Masson).—*Electrician* Electrical Trades' Directory and Handbook for 1896 (*Electrician* Company).

PAMPHLETS.—Report of S. P. Langley, Secretary of the Smithsonian Institution, for the Year ending June 30, 1895 (Washington).—Classification Chart of the Commoner British Orders of Flowering Plants: W. P. Winter (Cheltenham).—Über Germinal-Selection eine quelle Bestimmt Gerichteter Variation: A. Weismann (Jena, Fischer).

SERIALS.—Journal of the Franklin Institute, February (Philadelphia).—American Naturalist, February (Philadelphia).—Journal of the Chemical Society, February (Gurney).—The Asclepiad, Vol. 44, Vol. xi. (Longmans).—Proceedings of the Physical Society of London, Vol. 14, Part 2 (Taylor).—Journal of the Institution of Electrical Engineers, No. 119, Vol. xxiv. (Spon).—Internationales Archiv für Ethnographie. Band ix. Heft 1 (Leiden, Brill).—Astrophysical Journal, February (Wesley).—Strand Magazine, February (Newnes).

CONTENTS.

THURSDAY, FEBRUARY 27, 1896.

THE CATALOGUE OF SCIENTIFIC PAPERS.

Catalogue of Scientific Papers (1874-1883). Compiled by the Royal Society of London. Vol. xi. [Pet—Zyb]. Pp. 902. (London: Clay and Sons, 1896.)

THIS volume marks the completion of the third series of the Royal Society's contribution to the bibliography of science. With it the "Index Auctorum" for the ten years 1874-83 is completed, as originally planned, but in order to make the list of papers as exhaustive as possible, the Society are, as is known, actively preparing a supplementary volume to contain additional titles and references, taken from serials published not only during that decennium, but also of earlier date, which from one cause or another are not included among those at present indexed. When this supplement is issued, as we hope it may be within the next two or three years, we shall be in possession of a practically complete author-index to the whole vast mass of the serial literature of science, back from the year 1883 to the beginning of the nineteenth century.

Such a register, simple and straightforward, but accurately and systematically compiled, must always form an invaluable and indispensable basis on which to elaborate any further schemes of indexing which may attempt to furnish a guide to the contributions to each of the special departments of science. The whole problem, how best to grapple with the task of recording and indexing the ever-increasing mass of scientific literature, is one of the burning questions of the time for all cultivators of science. This problem the Royal Society have been steadily attacking since the middle of the century, when (in 1858) they commenced work upon their great Catalogue.

In our notice of vol. ix., the first of the present series (NATURE, vol. xlv. p. 338, February 1892), we gave a brief summary of the origin and progress of the Royal Society's bibliographical undertaking, and in the same article we referred to the long-canvassed and still unsettled question of a parallel subject-index. To this we will recur further on. Meantime, a short analysis of the contents of the series now completed may furnish some particulars at once instructive and interesting.

The total number of individual papers entered in the 2900 odd pages of these three volumes we estimate to be between 89,000 and 90,000. The number contained in the two volumes for the preceding decennium (1864-73) we make, by a similar estimate, about 70,000. This shows an increase of about 25 per cent., and such may probably be taken as fairly representing the actual amount of increase in scientific activity during the second ten-year period, on the assumption that the two series comprise a like proportion of the total literature of science. The original series, covering the long period 1800-1863, indexed the remarkably high total of 1500 publications. The exact number indexed for the second series (1864-73) is not quite apparent. The number for the present series is 570, a rather unaccountable decrease when compared with the large number just quoted, and undoubtedly too small to furnish a sufficiently exhaustive record of the scientific work of the world. The Society themselves recognise this, and, as we have said, are making provision for the amplification of the Catalogue by indexing some hundreds of additional serials. The greater part of these must doubtless be of minor importance, but there are also a considerable minority of publications of a high order of merit which, as we pointed out in our notice of vol. x. of the Catalogue (NATURE, vol. l. p. 241, July 1894), were unhappily not included in the list the Society originally worked from.

Of those indexed in this third series we count 192 publications bearing English titles, equal to about 33 per cent. of the whole; 116 French, or about 20 per cent.; and 165, or about 29 per cent., German. These numbers may possibly give a fair idea of the actual proportion obtaining between the contributions to the total literature of science as divided among these three languages; but we need not go further, and attempt to draw conclusions from them as to the relative scientific activity of the peoples speaking them.

The proportions in which the various branches of science contribute to the aggregate of serial literature is not very easy to determine. So far as a somewhat rough estimate may suffice, we should say that nearly 40 per cent. of the entries in the list of publications are devoted to general science, about 35 per cent. to biological, and 25 per cent. to physical and mathematical science. The distinction, however, is not always easy, but there seems a decided preponderance of biological over physical literature.

The printing of the three volumes of this series has occupied some six years, and the supplementary volume will, we imagine, not be issued before another two years at least, making a total interval of fifteen years between the date to which the work extends and the date of complete publication. It is easier to deplore these long intervals than to avoid them, especially while one Society endeavours to cope single-handed with the vast and ever-increasing mass of material. In his address at their last anniversary, Lord Kelvin said that "the continuation of such a work was almost beyond the resources of the Royal Society," and referred to the efforts that were being made to secure effectual international co-operation. As a step towards this, the Society have issued invitations to an International Conference to be held in London during the coming summer, at which the whole question of cataloguing and indexing the literature of science may be discussed from an international point of view, and at which it may be hoped the outlines of a scheme may be agreed upon, the details of which could be filled in later on. As a result co-operative work on a comprehensive and well-considered system might be definitively commenced, say, with the turn of the century, starting as from January 1, 1901.

If the same research work is often needlessly done twice or thrice over, it is equally certain the same cataloguing and indexing work is done needlessly many times over when once might have sufficed. To save this waste of time and labour, organised collaboration on a large scale seems the one thing needful, and we see no reason to fear that this cannot be successfully arranged. The desideratum of comprehensive and accurate subject-indexes makes itself more acutely felt with every year

that passes, and one of the questions of method which calls loudest for settlement is what particular plan should be adopted for the preparation of such indexes. The feeling of bibliographers now leans strongly towards the general adoption of the ingenious system of decimal notation devised by Mr. Melvil Dewey, the director of the New York State library—a numerical system of indicating and distinguishing the divisional sections and sub-sections of a classification to any desired degree of subdivision, the number affixed to an entry distinguishing not only the particular ultimate subdivision of the general subject, but at the same time indicating all the superior divisions to which the work in question also belongs. The merits of this principle of notation are independent of those of the elaborate classification of all literature which Mr. Dewey has laboriously prepared for use with it. The latter may be open to criticism, but it must be remembered that no classification is likely to satisfy every one. Some sacrifices are inevitable, and we believe that, even as it stands, Mr. Dewey's classification is a workable scheme adequate for most practical purposes. Indeed, American experience has tested this point for some years now. Accordingly, the International Conference of Bibliography, which met at Brussels last autumn, recommended the entire adoption of Mr. Dewey's system, which has also been approved and adopted, among others, and not to mention its American supporters, by the Association Française, the International Congress of Zoology, the recently-founded Institut International de Bibliographie (Brussels), and our Paris contemporaries, the *Revue Scientifique* and the *Revue Générale des Sciences.*

Other questions which remain to be settled by general agreement are the mode of preparing the material, the extent to which cognisance should be taken of the contents of papers as well as of their titles, the degree of subdivision to which classification should be carried, the terminology, and the language or languages to be employed. These and other associated questions are all ripe for settlement, and it cannot be said that any of them are beyond the reach of general agreement when all are convinced of the urgent need for their practical solution. Meanwhile schemes are formulating and maturing. M. Otlet, of Brussels, and his collaborators of the Institut de Bibliographie have developed and are applying a comprehensive system. The Faculty of Medicine of Harvard University have appointed a special committee to report on the question of a general bibliography of science. The French Ministry of Public Instruction is publishing a "Bibliographie des Travaux Scientifiques publiés par les Sociétés Savantes de la France."

About the last-mentioned work, an undertaking presenting, on a smaller scale, many points of similarity to that of the Royal Society, we may say a word or two. The idea originated with M. Milne-Edwards, and the work is being carried out by Dr. Deniker, the librarian of the Muséum d'Histoire Naturelle. It covers the long period from 1700 to 1888, and is to be divided into three sections. The first section, which is now going through the press, is an enumeration, volume by volume, of all the scientific articles contained in every serial, the serials being taken in alphabetical order of departments, and of the towns in each department, in which the societies are domiciled. The second section is to be the general "Index Auctorum," each title bearing as reference the *numéro d'ordre* prefixed to it in the first section; and the third section is to be the "Index Rerum," each entry again bearing its reference number as before. This plan may be open to criticism, but the bibliography will be a fine piece of work when completed, and, as we said, to some extent parallel to the Royal Society's Catalogue, and indeed duplicating a large fraction of its contents. While admiring the industry and enthusiasm of its compiler, we are bound to feel some degree of regret when skill, labour and time are thus expended upon isolated sporadic and unco-ordinated undertakings, while they might be far more efficiently employed in co-operating upon one well-considered and carefully organised international scheme. This is the direction which future indexing work must inevitably take, and we look forward with impatience to the realisation of this crowning development of the Royal Society's long-sustained labours.

NATURAL SELECTION AND ITS CRITICS.

Nature v. Natural Selection. An Essay on Organic Evolution. By Charles Clement Coe. Pp. 591. (London: Swan Sonnenschein and Co., 1895.)

THE author at the outset of this work tells us he "believes that the process of organic evolution has taken place, but he does not believe that natural selection has been the means by which that result has been brought about." The object of his work is the attempt to support the latter contention. He does not profess to speak as an expert, or to bring forward any new observations, but chiefly occupies himself with the quotation and criticism of isolated passages from previous writers. He evidently feels a very sincere disbelief in the adequacy of natural selection, and regards himself as compelled by some sort of inspiration to communicate this disbelief to the world.

It is evident that the criticisms are intended to be fair, and they are conceived in no unfriendly spirit, and expressed with no want of respect to the great writers on the subject; but the method of minute verbal criticism of single sentences and short passages is one which almost invariably leads to unfairness, however unintentional, and the work before us has certainly not escaped from this very natural tendency.

A few instances, upon all of which comment is superfluous, will sufficiently indicate the competence of the author to deal with his subject, and the spirit in which he approaches it.

In speaking (p. 23) of the two phrases (he unaccountably calls them "two contradictory theories"), "Natural Selection" and "Survival of the Fittest," he says: "It seems almost incredible that a great writer should have rejected the more accurate in favour of the sometimes more convenient phrase." He seems to forget that it was too late to withdraw a phrase which was already world-wide, and, furthermore, that convenience in such matters is of very high importance. As the author inquires why natural selection is more convenient, he may be referred to Darwin's "Life and Letters," in which the subject is

discussed in detail. His own remarks on this point afford a clear example of the means by which the unnecessary size of the volume has been attained.

In Book i., Chapter v., numerous examples of co-operation in nature are quoted from various writers, and it seems to the author "to be quite impossible to harmonise the demands of the theory of natural selection . . . with the co-operation which is constantly found in nature."

In attempting to account for the extermination of the black rat by the brown, on other grounds than those of natural selection pure and simple, we meet with the suggestion (pp. 107, 108) that the proportion of brown females was increased in consequence of the proteid diet of black rats!

Upon the destruction of the watercress in the New Zealand streams by means of the willow, he remarks—"There is no abstract survival of the fittest: both are equally fit apart from one another."

The work is divided into three books, each of which contains seven chapters. The first book discusses the possibility, the third the evidences of natural selection, while the second compares it with other attempts to explain evolution.

It would have been far better if the author could have found "peace"—to use his own phraseology—by performing a task of less herculean proportions. In these days of hurry and hard work the world will find it difficult, if not impossible, to absorb a message which requires 591 pages to deliver.

E. B. P.

OUR BOOK SHELF.

Minerals, and how to Study them: a Book for Beginners in Mineralogy. By Edward Salisbury Dana. 8vo, 380 pp.; 319 figs. (New York: Wiley and Sons. London: Chapman and Hall, 1895.)

A GLANCE at this volume is sufficient to show that we have here a book of the sort which is wanted for quite elementary students. A sentence chosen at random from the introductory chapter will indicate at once how it differs from the ordinary text-books, both in style and method. Speaking of the trial of hardness, the author says: "It is necessary to be sure and distinguish between a real scratch on a smooth surface and the crushing of a rough surface by the knife-edge; a very hard mineral may often be scratched in this way. The danger of making a mistake of this kind is made less if, besides the useful knife-point, the mineral be rubbed on a piece of glass; better have a piece at hand (not disfigure a window-pane). Only do not make the opposite mistake and call a white ridge left by a soft mineral on the glass, which can be easily rubbed off, a scratch." Here is a real attempt to guide the beginner through the pitfalls which beset an unwary student; how different from the usual bald statement of facts, in which the possibility of any difficulty which may occur is not even mentioned. The same is true of the excellent chapter on blowpipe-testing; thus: "Another trial may be made with sphalerite or zinc blende, but to succeed now the mineral should be pulverised first, since it is infusible before the blowpipe, and the compound is only with difficulty decomposed on charcoal," &c.

It is of course difficult to maintain this style of writing when the author comes to the description of the various mineral species, but in that portion of the book also he has contrived to present the facts in attractive language and make them interesting to an elementary student, and he is content to describe only the most important minerals; the smaller text-books at present available, excellent though they may be in other respects, are usually condensed epitomes of the larger treatises; they contain too much, and are not written in simple language calculated to engage the attention of beginners.

The book closes with an excellent chapter on the determination of minerals, full of useful and suggestive hints.

As might be expected from the author, or joint-author, of the best and most exhaustive treatise on minerals which exists, Prof. Dana's book, though elementary, maintains throughout a high standard of scientific method.

From the educational point of view, we note some striking defects due to the use of language which, though picturesque, may be misunderstood by a beginner. For example, the statement that "the reflecting goniometer demands polished faces if good results are to be obtained," will inevitably suggest the need of artificial polish to the student who takes all things literally; a similar misunderstanding will be produced by the description of Chalcotrichite as a variety of Cuprite, in which "the cubes are spun out into long threads."

The illustrations are mostly new, and among them are many good pictures of typical minerals; it is only unfortunate that the figures of the simple forms and combinations in the third chapter are so shaded that the faces appear concave. These defects can be easily corrected in a second edition, and do not detract from the merits of the book as a really useful and attractive introduction to mineralogy, which can be safely recommended to beginners.

H. A. M.

Heating and Ventilating Buildings. By Rolla C. Carpenter, Professor of Experimental Engineering, Cornell University. Pp. 400. (New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1895.)

THE subject of heating and ventilating buildings has of late years been more and more considered by engineers in this country. In the United States, on the other hand, the question has received satisfactory treatment, and we have therefore much to learn from the systems in vogue there. The object of this volume is to present to the reader a general idea of the principles which apply, and of the methods of construction usually adopted in various systems of heating and ventilating. The author deals with the subject in a clear and concise manner, the information given being the result of extensive practice in designing and operating heating apparatus. Taken as a whole, the volume is of much value; it is well printed and nicely bound.

The author divides the matter into sixteen chapters, commencing with a description of the "nature and properties of heat"; he very fully enumerates the many laws pertaining thereto. On the general principles of ventilation we find much useful information. Some experiments made by Mr. Warren R. Briggs, of Bridgeport, Conn., on the subject of the proper method of introducing pure air into rooms, and the best location for the inlet and outlet, are described. The illustrations showing graphically the results are highly interesting, the best being obtained by placing the air inlet on the side of the room near the top, and the outlet in the bottom and near the centre of the room. The outlet, of course, must be connected with a flue of ample size, and maintained at a temperature higher than that of the surrounding air. Many authorities are quoted, and extracts from technical papers are given. The loss of heat through walls of various thicknesses is pointed out, and Mr. Alfred R. Wolff's lecture before the Franklin

Institute on this subject is referred to. As the majority of systems make use of heat supplied by radiating surfaces, the author, in chapter iv., very fully explains what is meant by the various terms, and then proceeds to describe the methods of testing radiators at Sibley College to measure the heat discharged. The results obtained are brought together in a table; further tests being given from radiators with extended surface so as to form air-flues.

The remaining portion of the book deals with the practical details and metallic parts of design, and architectural considerations. Much sensible advice is imparted as to the care of steam-heating boilers, and how to avoid boiler explosions, of which statistics are given. We notice many useful rules and formulæ for various purposes when designing a hot-water or steam-heating system. The volume lifts the subject out of the hands of the "plumber," and leaves it in the hands of the "engineer." Prof. Carpenter is to be congratulated on producing a really good book on a subject seldom treated scientifically.

Lessons in Elementary Botany for Secondary Schools. By Thomas H. Macbride. Pp. 233. (Boston: Allyn and Bacon, 1896.)

IN his far-reaching essay on "Education," Mr. Herbert Spencer remarks: "In education the process of self-development should be encouraged to the uttermost. Children should be led to make their own investigations, and to draw their own inferences. They should be *told* as little as possible, and induced to *discover* as much as possible." It is satisfactory to all who are concerned in the progress of science, to know that these sound principles of scientific instruction are being brought more within the region of practical education every day. The present volume is an addition to the steadily growing literature in which the principles referred to are applied. The young students, for whom the book is intended, are led to make their own observations; they are induced to study plants, rather than printed books, and thus to derive their knowledge at first hand from nature. The opening lesson in the book is typical of the fifty-three which follow it. The pupils are told to collect the twigs of various trees or shrubs and to compare them, noting various peculiarities. A single twig is then examined, and attention is directed to the arrangement of the buds and leaf-scars upon it. In the second lesson, twigs are compared with particular reference to buds and their relations to branches, and are grouped according to bud-arrangement. The structure of stems afterwards forms the subject of several lessons, and then the root, leaf, flower, fruit and seed are studied in succession, after which come lessons having for their object the elucidation of the structure and history of individual plants and trees. Much more attention is given to trees than is usual in books on botany. The book is hardly suitable for class use on this side of the Atlantic, but an English edition of it would be welcomed by many teachers of botany.

Vegetable Culture. By Alexander Dean, F.R.H.S. Pp. 136. (London: Macmillan and Co., 1896.)

METHODS and results are what amateur gardeners, cottagers, and allotment-holders want, and this is the book to supply their need in regard to the culture of vegetables. Theirs not the ambition to ask the reason why, but merely to know exactly what to do in order to reap rich fruits of their industry. Very admirably does the author impart this kind of information. In concise language he describes the best methods to be followed in the preparation and after-treatment of the soil, the best varieties of the various classes of vegetables, and the best systems of cultivation. Both the text and the illustrations are instructive, and together they make up a sound and serviceable primer for gardeners.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Röntgen Rays.

IT may interest your readers to hear that, with the assistance of Mr. J. C. M. Stanton, I have succeeded by means of the Röntgen rays in actually seeing the coins inside a leather purse, the metal instruments inside a closed wood and leather case, a coin through a piece of wood half an inch in thickness, and also through a sheet of aluminium.

Photography was not employed, but the shadows of the enclosed objects were made directly visible to the eye by means of a fluorescent screen.

The precise arrangement was similar to that recently described by Prof. Salvioni, of Perugia, whose results, though in accordance with certain experiments of Prof. Röntgen, confirmed, I understand, by Mr. Porter, of University College, have so far been received in this country with a certain amount of scepticism.

The apparatus consisted of a tube of opaque paste-board with a simple aperture at one end, to which the eye was applied. The other end was provided with an opaque diaphragm of double black paper, upon which, on the inner side, was laid a piece of blotting-paper impregnated with platino-cyanide of barium in a crystalline state.

The purse or other object was held against the diaphragm with the Crookes' tube beyond it, so that the rays from the latter cast a shadow of the coins through the leather and black paper upon the inner impregnated screen. The platino-cyanide fluoresced brightly under the stimulus of the rays on those portions of the blotting-paper where no shadow was cast, and consequently the form of the metallic objects was made clearly visible. Non-metallic objects were also clearly seen, though more faintly, owing to their greater transparency to the rays.

Besides being exceedingly interesting in itself, and possibly capable of sufficient improvement to render it of service in medicine and surgery, the appliance will be very useful for the purpose of ascertaining, without the tedious process of exposing and developing a plate, whether any given Crookes' tube is suitable as regards exhaustion and form for photographic purposes.

It can be seen at once whether the tube is working to the best advantage, and is giving clearly defined shadows.

The place on the glass of the tube from which the maximum radiation is proceeding, can also be easily determined, and I may mention as confirming a point previously noticed by myself—*i.e.* that a tube with a well-marked fatigue spot on the glass will not answer satisfactorily for photography—that with the above-described instrument the fatigue spot is visible to the eye through the black paper, thus showing that the glass when fatigued does not transmit the Röntgen rays. A. A. C. SWINTON.

66 Victoria-street, Westminster, February 25.

P.S.—Since writing the above, I have been able to see distinctly the bones in the thick portion of my own hand.

AS the hand appears to feel a cold sensation when exposed to the X-rays, an experiment was made with the thermopile to put the matter to the test. This showed that heat was being radiated from the phosphorescent patch in the Crookes' tube; if the current be reversed so as to make the opposite pole the anode, then heat was again radiated, but in a very much smaller amount. The phosphorescent patch becomes very markedly warmed in some tubes. On replacing the thermopile by a lighted candle, the flame exhibited a flickering motion, and was slightly drawn towards the phosphorescent patch; this could be observed at a distance of six inches. The phenomenon was also observed when the candle was placed on the side of the tube opposite the anode, but less markedly. A flame is almost transparent to the X-rays; on taking a shadowgraph of a lighted candle or gas jet, the shadow of the flame is just visible as an exceedingly faint impression, the internal core in the case of the gas flame being slightly more marked than the external.

Edinburgh. DAWSON TURNER.

The Cause of an Ice Age.

THOUGH I have no wish to prolong this discussion, yet I will ask you to spare me space for a few lines.

In his last letter, Sir Henry Howorth expresses his belief that, as a consequence of the recent correspondence, I have been led to change the opinions I previously held as to the cause of an Ice Age. May I assure Sir Henry Howorth that he must have quite mistaken the purport of my letter.

With all due courtesy to Sir Henry Howorth, as well as to any others who may have differed from me, I may say that I have seen no reason to swerve from the belief that the position taken in my book on "The Cause of an Ice Age" is the sound position. My opinions are, therefore, unchanged.

I would like to take this opportunity to thank Dr. A. R. Wallace for his letter on this subject in your columns, and to express the satisfaction with which I found that he had been led to the same conclusion, with respect to Mr. Culverwell's argument, as that at which I had myself arrived by an independent method. I note that Mr. Culverwell dissents: but, even at the risk of being thought very obstinate, I must say that I still believe Dr. Wallace and I are right. ROBERT S. BALL.

So far as I know, it has not been suggested that a comparatively small elevation of the crust of the earth would cause a glacial state in the elevated part. The roughness of an ordinary terrestrial globe, representing an elevation that might be compared with the thickness of letter-paper, would correspond with an elevation of the crust of the earth that even in the tropics would cause perpetual snow. A few thousand years would be sufficient to cause a sufficient elevation without any catastrophic hypothesis. THEODORE RYLAND.

The Measurement of High Temperatures.

IN a valuable paper on the "Determination of High Temperatures" (*Wied. Ann.* 1895, No. 10), Messrs. Holborn and Wien give the results of their observations on the changes in the resistance of platinum wire over a range of 0° to 1600° C. The authors come to the conclusion that the relation between temperature and resistance "cannot be accurately represented by the Callendar and Griffiths formula"; although, on the other hand, they admit that by means of that formula Heycock and Neville have determined a number of melting points which are in good agreement ("die sich in guter Uebereinstimmung mit unsern Werthen befinden") with the values found by Holborn and Wien when using a thermo-couple standardised by direct comparison with the air-thermometer.

Platinum thermometers are now so generally used for high temperature measurements that an adverse conclusion of this kind is a matter of importance, especially when associated with the names of accurate observers such as Holborn and Wien.

I trust, therefore, that a brief criticism will not be regarded as out of place.

I would first remark that my delay in commenting on this paper is not due to any want of respect for the authors, but from a sense of the importance of the matter. Before attempting any reply, I wished to ascertain the views of Prof. Callendar, and I accordingly wrote to Montreal calling his attention to the paper, but I have not as yet received his answer. I feel, however, that further delay is undesirable.

Neither Prof. Callendar nor I have at any time claimed that the relation between t and pt, as given by the empirical formula, has been *rigorously* verified at temperatures exceeding 600° C.

In NATURE, November 1895, p. 40, I wrote as follows:— "Results of this kind prove that even if the reduction does not express the temperature accurately in the air-scale, it at all events gives us a *constant* scale in which all high temperatures can be expressed, and it is further evident that this constant scale differs but little (even at these high temperatures) from the true air-scale."

The context shows that the "high temperatures" referred to were those in the neighbourhood of 1100° C.

The above quotation defines my own position with sufficient accuracy, and I will therefore pass on to consider the work of Messrs. Holborn and Wien.

(1). The authors state that the platinum wires (in experiments up to 1200° C.) were placed in an externally glazed porcelain tube, and isolated from each other by means of special porcelain capillaries ("die Drähte wurden durch besondere Porzellan Capillaren von einander isolirt"); and at higher temperatures "in externally glazed tubes of a very infusible substance, and isolated from each other by capillaries of the same material."

From this description it appears evident that the wire was in contact with the porcelain, or the other material, probably throughout the greater portion of its length; otherwise it must have been subjected to some strain. Now, contact with porcelain or any similar substance has been found by us to be absolutely fatal: if by any chance the wire has come into contact with the walls of the surrounding tube at high temperatures, the coil has had to be replaced by a new one. This is probably caused by the action of the silica: but whatever the reason may be, the effect has long been known, and care has been taken to avoid this source of error.

It is true that in the present form of the platinum thermometer the wire comes into contact with mica, and I have little doubt that some similar action (although in a lesser degree) takes place between the platinum and the mica. The method of constructing the framework and coil, however, causes the length of platinum in actual contact with the mica to be but an exceedingly small fraction of the length of the wire (probably less than $\frac{1}{100}$th), and thus any such effect is diminished. I think it possible that the small changes at high temperatures to which I have called attention in NATURE, (November 1895, p. 40), are in some measure due to action at the points of contact.

Unless Holborn and Wien took greater precautions in regard to this matter of contact between case and wire than they indicate in their paper, there is no need to seek for further explanation of the somewhat erratic behaviour of the two platinum wires examined by them; in fact, other experiments by the same observers show how materially the resistance of platinum is affected by exposure to the action of silica or hydrogen.

(2). No adverse conclusion should be drawn from the changes in their Wire No. I., for the authors state that "at the termination of the observations the protecting tube was found to have broken in the oven, and the wire had been exposed to the gases of the oven."

The necessity of complete protection from the furnace gases has from the first been insisted upon by those accustomed to the use of platinum thermometers. It was want of attention to this essential matter which led the B. A. Committee of 1874 to a false conclusion. The behaviour of Holborn and Wien's Wire I. has no significance or value, except in so far as it emphasises the importance of complete protection. It appears doubtful if sufficient precautions were taken in this matter with regard to their series of experiments with the platinum Wire II. The infusible tubes which they used for the air-thermometer bulbs at high temperatures were covered externally with a glaze. The authors say: "As the glaze in this case and also in the porcelain becomes liquid much sooner than the softening point of the material, we made use of our method by which there must always be a smaller pressure inside the vessel than outside. Under these conditions the glaze is pressed into the pores of the tubes, otherwise it would immediately come off."

Now I do not find any mention of a similar precaution when heating the platinum wire in what appear to have been similar tubes; it is possible, therefore, that the changes observed in Wire II. were also in some degree due to contamination by furnace gases.

(3). The authors speak of Wire II. as formed from "pure platinum" ("*Aus reinem Platin*"). They give the value of its temperature coefficient as—

Before heating	·003801
After ,, ...	·003783

As a general rule, the purer the platinum the higher its coefficient. The samples used by us (as, for example, in the Kew Observatory thermometers) have coefficients which vary from ·003860 to ·003880. It would hardly appear, therefore, that the wire used by Holborn and Wien merits the term "pure." The purity is, however, not of great consequence, as (see NATURE, November 1895, p. 40) we have found that although the coefficient depends on the purity, the deduced temperatures are unaffected provided that the coefficient is not reduced by the impurities to lower than about ·0032. The fall in the coefficient (above indicated) is, however, of great significance, and in itself is evidence that the wire had become contaminated during the experiments. Assuming (as was doubtless the case) that the wire had been previously annealed, the above change sufficiently establishes inadequate protection of the wire.

I have carefully investigated the numbers in Table II., where the authors give the results of their observations on this second specimen of "pure platinum." I am unable to draw any con-

clusion from the figures there given, except that this wire, either from its quality or its situation, behaved in a different manner from any one of the many specimens I have examined during the past five years. The value of $\delta R/\delta t$ decreases with increase of temperature in a most phenomenal manner.[1] In cases in which I have observed this phenomenon in a lesser degree it has indicated a breaking down in the insulation, consequent on rise in temperature. I am unable to find any evidence that the insulation was tested at high temperature during these experiments.

(4). Any expression of opinion by Messrs. Holborn and Wien necessarily carries weight; nevertheless, I would venture to suggest that (considering the amount of experimental work previously performed by those who advocate the methods of platinum thermometry) the examination of only two wires, one of which was admittedly exposed to the action of furnace gases, affords insufficient grounds for the adverse conclusions arrived at by the authors.

(5). Heycock and Neville's determinations of the freezing points of copper, gold, and silver are admitted by Holborn and Wien to be in "good agreement" with their own. The nature of this agreement is shown in the following table.

	Heycock and Neville.	Holborn and Wien.
Copper	1080·5	1082
Gold	1061·7	1072
Silver	960·7	971

It is worthy of notice that copper is the only metal of which Holborn and Wien used large quantities, comparable with the masses experimented on by Heycock and Neville. Also in this case Holborn and Wein determined both melting and freezing points. Their results (using practically the same thermometer throughout) range from 1076° to 1093°, whereas Heycock and Neville's values, when using six distinct platinum coils possessing very dissimilar constants, range from 1079°·0 to 1081°·7, a very different order of agreement.

In the case of gold and silver, Holborn and Wien used small quantities, determining their results by observations of the *melting* points, and thus the method of experiment adopted renders it probable that the temperatures observed would err on the side of excess. The close agreement in the case of copper, and the higher values found by Holborn and Wien in the experiments on gold and silver, are therefore significant.

Thus, when the conditions are similar (as in the case of copper), we may regard the results obtained by the different observers as practically identical. Such agreement would be impossible if platinum resistance thermometers ordinarily underwent, at high temperatures, changes of the nature of those observed in the wires studied by Holborn and Wien. The differences would then be measurable not by units, but by tens and hundreds! and these discrepancies would be found not only when different methods were used, but also when the same observations were repeated with different platinum thermometers.

If Tables XI., XII., and XIII. of Heycock and Neville's paper[2] are examined, it will be found that although in each case from 6 to 8 different platinum thermometers were used in which, for example, the value of δ varied from 1·495 to 2·04, the extreme resulting temperatures differ by a smaller quantity than the differences obtained by Holborn and Wien when repeating an observation without change in the conditions, by means of the same thermo-couple.

Finally, I assert that Holborn and Wien have produced no evidence sufficient to support the somewhat sweeping conclusions given by them on p. 394 of their paper. I have shown that in their experiments on only two samples of wire, they have neglected the precautions insisted upon by those who have devoted years of study and experiment to the investigation of the platinum thermometer, and this portion of their work is only useful in so far as it emphasises the validity of the conclusions arrived at by those who preceded them.

I fully appreciate the great value of Holborn and Wien's direct determinations of high temperatures by means of the thermo-couple and the air thermometer, and I admit it is probable that for temperatures exceeding 1400° C. or so, the thermo-couple is the more convenient, and possibly the more accurate instrument. Below such temperatures, however, I consider that the weight of evidence is in favour of the accuracy of the platinum thermometer. In any case, such evidence is in no way weakened by the experiments of Holborn and Wien.

E. H. GRIFFITHS.

[1] This extraordinary behaviour of Holborn and Wien's Sample II. (for reasons previously given the behaviour of Sample I. is of no significance) is noticeable in the numbers attained by them at *low*, as well as at high, temperatures.

[2] *Chem. Soc. Trans.*, 1895, pp. 188-190.

Earth Tremors.

IN Prof. Milne's article in NATURE of December 26, he states that earth tremors are more frequent during the winter than during the summer, that they are frequent with a low barometer, and still more frequent when the locality of observation is crossed by steep barometrical gradients. In the North-West Himalayas, throughout the winter months, slight earth tremors are exceedingly frequent, and occur, so far as can be judged without instrumental records, more frequently by night than by day. This may be in part due to the fact that during the day most people would be moving about in downstairs rooms, while at night the same people would be in upstairs rooms, and both they and their surroundings perfectly quiet; but, whatever may be the day and night relation, there can be no doubt that during the winter months in Simla peculiar little earth tremors are remarkably frequent. My experience has been that these tremors are not so much connected with areas of low barometer as with the *commencement* of a sudden and large change in atmospheric pressure from a high to a low, a reduction of pressure which need not necessarily be accompanied with steep barometric gradients or high winds at or near the earth's surface. In the case of earthquakes, also, I have noticed subsequent large changes in atmospheric pressure. Thus at about midnight on January 15-16, 1896, a (for these regions) rather severe earthquake occurred, which lasted from 1m. 20s. to 4m. in different localities. On the plains the most severe shocks were felt at midnight, 15th, at Simla, at 0h. 30s. a.m. on the 16th, and at Srinagar at 1 a.m. on the 16th. Times for other places in the Punjab were published in the newspapers, but I have omitted to keep them. The above, however, show that the shock was felt at Lahore at midnight, at Simla half an hour later, and at Srinagar an hour later. The barometric records show that for the forty-eight hours from 8 a.m. on the 16th to 8 a.m. on the 18th, pressure changed as follows:—

	"
Srinagar (Kashmir)	−0·187
Astor ,,	−0·062
Murree	−0·165
Lahore	−0·144
Simla	−0·140
Quetta	+0·022

From the above figures, it appears that a considerable decrease of barometric pressure occurred between the morning of the 16th and the morning of the 18th, and that this fall was central over Srinagar; while the times of occurrence of the earthquake show that the movement of terrestrial disturbance was directed towards this central area of diminishing pressure. It has always appeared that the atmospheric changes which ordinarily occur in tropical and subtropical countries would be a wholly inadequate cause to account for the considerable earthquakes which at times occur; but I have undoubtedly noticed that very slight earth tremors constantly take place when a sudden and large decrease in atmospheric pressure *commences* after a considerable period of high pressure.

W. L. DALLAS.

Simla, January 29.

"Roches moutonnées."

SOME ten years ago, I came across in an old memoir a rational explanation of the term *roches moutonnées*; but I made no note at the time, and have been unable to trace the reference. However, my scepticism was fortified, and I proceeded to search French dictionaries, which made it clear that *moutonné* meant "frizzled like sheep's wool," and not "sheep-like." Yet M de Lapparent tells us ("Traité de Géologie," 3me ed., p. 281) that these glaciated rocks "produisent une impression analogue à celle d'un troupeau de moutons endormis, d'où le nom de *roches moutonnées*"; and who shall question this precise statement of a French author interpreting his own language? It is the explanation that has been taught to all of us, though I know of only one field-geologist who seriously maintains that *roches moutonnées* might be taken for a flock of sheep. Agassiz states

that De Saussure is the author of the term; but I have long been foiled by its omission from the index of the famous "Voyages dans les Alpes." In "Open-Air Studies," however, I ventured to compare the mammillations of a glaciated surface to those upon an antique wig; but all the time, it seems, Mr. Whymper held the key of the matter for us, in a passage which has escaped the memory even of Prof. Bonney (see "Ice-Work," 1896, p. 10). Mr. Whymper, in fact ("Scrambles amongst the Alps," fourth edition, 1893, p. 133), supplies the reference to De Saussure; and in the "Voyages dans les Alpes," 1804, tome ii. p. 435, par. 1061, we may read of what are styled in the margin "montagnes moutonnées." De Saussure states that behind Envionne (the modern Envionnaz), in the upper valley of the Rhône, "ces rondeurs contiguës et répetées forment en grand l'effet d'une toison bien fournie, ou de ces perruques que l'on nomme aussi *moutonnées*." In face of this, there is no longer any need to tax the credulity of our pupils with a fanciful explanation, which we seem to have forced even upon French-speaking peoples.

GRENVILLE A. J. COLE.

Royal College of Science for Ireland,
Dublin, February 17.

The Age of the Present Canadian Flora.

PROF. D. P. PENHALLOW has recently identified some fragments of wood found in the Leda clays of Montreal, as *Picea nigra*, the common black spruce. This is another addition to the group of plants which represent our present knowledge of the flora of Canada in Pleistocene times. This Pleistocene flora may now be taken to include not merely the plants found in these Leda clays and in the clays believed to be equivalent to them in age in Ontario, but also the ancestors of the present inland maritime flora found on the shores of the Great Lakes, hundreds of miles from the sea-coast, and of the plants which are common to Europe and America, and which include so many arctic and sub-arctic, as well as northern temperate species. The inland maritime plants, and probably also the sub-arctic species now found so far south as the headlands of Lake Superior, made their way to their present localities during the deposit of the Leda clays when a considerable part of Eastern Canada was submerged. Six of the species which occur in the Leda clays at Ottawa and Montreal, and thirteen of the inland maritime plants, as well as several of the Lake Superior sub-arctic species, are also European, showing that at that period the intermingling of the American and European floras was well established, but leaving open the possibility of these plants common to the two continents being even older than the period of the Leda clays.

The intermingling of the Asiatic and American floras appears to have taken place at a still earlier period. The oldest known representatives of the existing Canadian flora are those few identical species found by Mr. Lester F. Ward in the Laramie rocks of the Western United States—rocks which Sir William Dawson refers to the Lower Eocene. Two of those identified now occur in both Japan and Canada; and one, still living in Japan, has, if correctly identified, become extinct on the American continent. Again, among the Leda clay and inland maritime plants there are several species which are likewise common to the two countries. The intermingling of Asiatic and American plants evidently took place prior to the upheaval of the Rocky Mountain chain, as the extensive flora peculiar to British Columbia, Oregon, and southward, is almost without a representative in Japan. This British Columbia flora, so well represented by various species of Claytonia, Lupinus, Trifolium, Astragalus, Saxifraga, &c., as well as Coniferæ, is of more recent birth—probably Later Tertiary and Post-Tertiary.

The most recent creations in Canada would appear to be the plants which—well represented by Compositæ, an order of no great antiquity—are now so marked a feature of the prairies of Manitoba and the surrounding country—prairies which in some places are still in process of formation.

A. T. DRUMMOND.

Children's Drawings.

WITH regard to young children drawing upside down, I have for some time past collected observations. It is certainly true, that a great many children do draw in this way; on the other hand, many from the first draw the right way up. I have seen a boy of four, when asked to draw a rook on a haystack, begin at the bottom of the paper with the rook's back, and gradually work his way up to the haystack; he then turned it round, and handed it to me to look at, evidently realising that it was inverted.

I do not think the explanation depends in any way on the inversion of the retinal image. If a child, who draws upside down when drawing on a horizontal table, is asked to draw on a blackboard placed vertically, he will draw everything the right way upwards. It seems to me, that the explanation simply is that the child has to draw an object, which he has seen in a vertical plane, on paper placed in a horizontal plane—an extremely difficult task to him—and it is a mere question of convenience to him at which end he begins, both being equally wrong from his point of view. This will also explain why children sometimes look at picture-books upside down, and also why small children are much more ready to draw objects, which they have been accustomed to see in a horizontal plane, such as a plate with oranges on it, than an erect object.

The Old Palace, Richmond. RINA SCOTT.

THE RÖNTGEN RAYS.

THE discovery by Prof. Röntgen of the rays which bear his name has aroused an interest perhaps unparalleled in the history of physical science. Reports of experiments on these rays come daily from laboratories in almost every part of the civilised world. A large part of these relate to the methods of producing Röntgen photographs, and the application of the "new photography" to medical and other purposes. A considerable amount of work has, however, been done on the physical properties of these rays; this has entirely confirmed the results stated by Röntgen in the paper in which he announced his discovery. The freedom of refraction of these waves, in which they are different from ordinary light, has been the subject of direct experiments made by M. Perrin and by Dr. Joly, while Dr. Lodge and others have confirmed the absence of any deflection in the magnetic field which differentiates these rays from the ordinary kathode rays.

Up to the present, however, no phenomena have been observed which enable us to say whether these waves are or are not transverse vibrations of very small wave-length, longitudinal vibrations, or even vibrations at all. Nothing of the nature of polarisation or of interference has been described. The absence of polarisation can at the present stage of the investigation hardly be pressed as an argument against these rays being transverse vibrations. For, of the three methods of producing polarisation in light —reflection, refraction, and absorption—only the latter is available for these rays. Now the number of substances which produce sensible polarisation in ordinary light by absorption is very small, and unless a much larger number possess this property for the Röntgen rays, it is hardly likely that, even if there are such substances, they would have been discovered in the three months which have elapsed since the publication of Röntgen's discovery. I may remark that I have made a large number of experiments on the opacity to these rays of plates of tourmaline (1) with their axes crossed, (2) with their axes parallel, testing the intensity of the rays which came through in some cases by their action on a photographic plate, in others by the discharge they produced in an electrified plate on which they were incident. The result of these experiments was entirely negative, for although the tourmaline plates produced very considerable absorption of the rays, no difference was detected between the absorption when the axes were crossed and when they were parallel. It is very desirable that a large number of substances should be tested in this way.

M. C. Henri has made the very interesting observation that an opaque coin coated with the phosphorescent sulphide of zinc will allow these rays to pass through it; the details of this experiment will be received with much

interest. I have found that when the Röntgen rays pass through any substance, they make it for the time being a conductor of electricity, even although the substance is in its normal state a perfect insulator. Thus solid paraffin, paraffin oil, solid sulphur, ebonite, mica, air—all conduct electricity when the Röntgen rays pass through them. This explains the fact observed by Righi, Bergman, and myself, that an electrified plate in air loses its charge when exposed to these rays, whether it be electrified positively or negatively. The air is converted into a conductor by these rays, and the charge escapes through it. It is not necessary that a gas should surround the plate, as I have found that the leakage takes place whatever the medium surrounding the plate may be. That this leakage is due to the condition of the insulator, rather than to that of the plate, is shown by the fact that it occurs when the plane of the electrified discs is parallel to the rays, as well as when it is at right angles to them. The air through which these rays have passed retains traces of conductivity for some little time after the rays have ceased to pass through it; this can be shown by blowing the air, from a place where the rays are plentiful, against a charged disc placed where there are only a few rays; the rate of leak from this disc is much increased by the blast.

With the assistance of Mr. J. A. McClelland, of Trinity College, Cambridge, I have made a large number of measurements of the rate of leak from positively and negatively electrified discs surrounded by air, and have found that the rate of leak in the two cases is almost identical. We have also made a series of measurements of the rate of leak through air at different pressures; the rate of leak is greater at a high pressure than at a low one, and is over a wide range of pressures approximately proportional to the square root of the pressure. The rate of leak is also greater in air than in hydrogen, being at atmospheric pressure about twice as great in air as it is in hydrogen, while the leakage through carbonic acid gas is faster than that through air.

The leakage of electricity through non-conductors is, I think, due to a kind of electrolysis, the molecule of the non-conductor being split up, or nearly split up, by the Röntgen rays, which act the part played by the solvent in ordinary electrolytic solutions. If the air through which the rays are passing is ionised, the number of ions would, according to the well-known law of dissociation, be proportional to the square root of the pressure, provided the amount of ionisation is small. Thus the result we obtained for the rate of leak through air at different pressures, indicates that the rate of leak is proportional to the number of ions.

The view that the air is turned by these rays into an electrolyte, is supported by some experiments made in the Cavendish Laboratory, by Mr. Erskine Murray, on the contact difference of potential between metal plates in air. He finds that when the Röntgen rays are passing through the air in the neighbourhood of the plates, the plates (as far as their potential differences are concerned) behave as if they were connected by an electrolyte.

Mr. C. J. R. Wilson has investigated, in the Cavendish Laboratory, the effects produced by Röntgen rays on the condensation of clouds caused by the expansion of air, and has found that when the rays pass through the vessel in which the cloud is formed, the cloud is very much denser than when the rays are absent, showing that these rays increase the number of nuclei which act as centres of cloud condensation. The ions with their electrical charges would act as such nuclei, so that this, again, is in favour of the view that these rays turn the air into an electrolyte. These experiments seem to show that these rays exert a powerful disintegrating effect on the molecules of substances through which they pass, and suggest that their use may throw light on some questions of molecular structure. It would be interesting, for example, to find the rate of leak through gases which are reputed to be monatomic, such as mercury vapour, argon, and helium. Again, if air and other gases can be made to act as electrolytes, we could use a mercury dropping arrangement, similar to that employed by Ostwald to measure the potential difference between metals and liquid electrolytes, to measure, by means of it, the potential difference between metals and various gases through which the Röntgen rays are passing.

By measuring the rate of leak from a disc charged to a fixed potential, we can compare the efficiency, as producers of Röntgen rays, of different tubes or of the same tube at different periods. The conclusion I have arrived at, by means of such measurements, is that bulbs generally improve for some time after they are sealed off from the pump, and attain a maximum efficiency, after which they begin to deteriorate.

Some measurements of the absorption of Röntgen rays by various thicknesses of metal, have led me to the conclusion that the Röntgen rays are not all of the same kind. The experiments were made by measuring the change of the rate of leak from an electrified disc, produced by changing the number of sheets of tinfoil interposed between the disc and the phosphorescent tube. When a small number of sheets of tinfoil were interposed, the addition of another sheet of tinfoil produced a very considerable diminution in the rate of leak; when, however, the phosphorescent bulb was a very good one, a considerable leakage remained when the number of sheets of tinfoil was considerable, and this "residual leakage" diminished but slowly as the number of sheets of tinfoil was increased. This seems to indicate that while there are some rays which are rapidly absorbed by the tinfoil, there are others which can pass through it with comparative facility. It is only when using one or two of the most efficient bulbs that I have remarked this "residual leakage," but with these bulbs when in their most efficient state it was very marked.

J. J. THOMSON.

THE DEEPEST SOUNDING YET KNOWN.

IN NATURE (vol. lii. p. 550, October 3, 1895), I mentioned that H.M.S. *Penguin*, Commander A. F. Balfour, R.N., had found in the Pacific Ocean deeper water than any yet known in lat. 23·40 S., long. 175·10 W., but had failed to reach the bottom owing to breakage of the wire at 4900 fathoms.

Captain Balfour has been enabled to try again, and I have just received the announcement of his obtaining three satisfactory soundings of over 5000 fathoms.

The deepest trustworthy sounding heretofore known is 4655 fathoms near Japan, obtained by U.S. S. *Tuscarora* in 1874.

The deepest of the *Penguin's* casts is 5155 fathoms, or 500 fathoms (3000 feet) deeper; but it is especially remarkable that the three casts now obtained are not in the same hollow, but are separated by areas of considerably less water, the two extreme soundings being 450 miles apart.

The usual abysmal red clay was brought up by the sounding-tube on two occasions; on the third the wire broke.

Mr. V. Thorpe, surgeon of the *Penguin*, reports that a microscopic examination of the specimen from 5147 fms. shows that the remains of siliceous organisms are almost, if not entirely, absent. The mineral particles are in a minute state of disintegration, and consist of exceedingly fine flocculent matter, mixed with pumice and other glossy volcanic products, green crystals of augite and reddish crystals of pelagonite.

These deep hollows furnish fresh evidence to the observed fact that all the extreme depths in the ocean

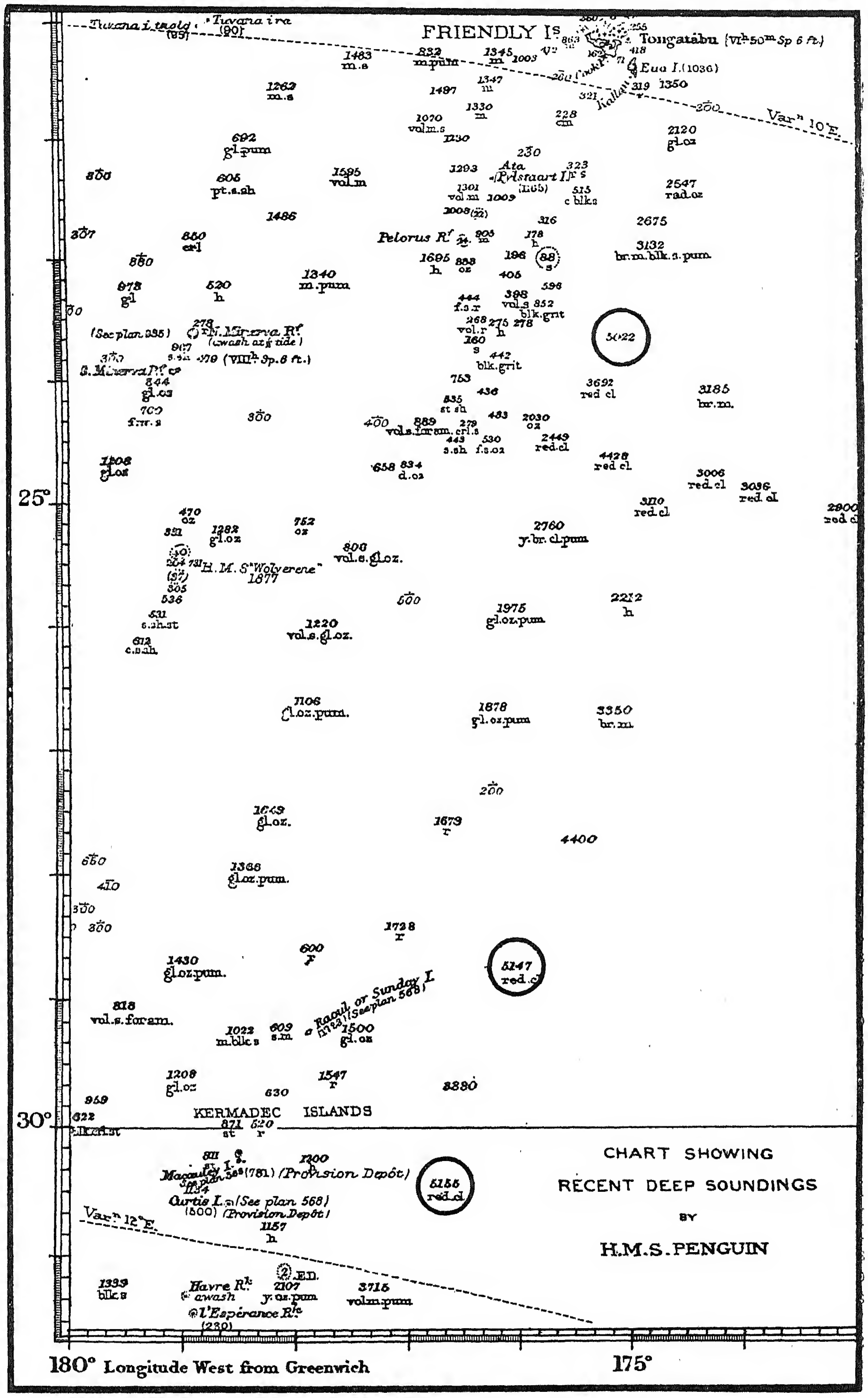
are near land or shallow water, and apparently follow the trend of such upheaved parts of the earth's crust.

The positions of the soundings are:—

Lat. S.	Long. W.	Depth. Fms.	Feet.	Nature of bottom.
23° 39′	175·04	5022	30,132	(Wire broke.)
28° 44′	176·04	5147	30,882	Red clay.
30° 28′	176·39	5155	30,930	Red clay.

The attached chart shows their general position, the Kermadec Islands being 500 miles north-east of Auckland in New Zealand.

W. J. L. WHARTON.



THE DESTRUCTION OF TREES BY LIGHTNING.

IN an article[1] by Dr. Carl Müller, on the probable causes which induce lightning to strike certain kinds of trees and not others, the writer brings together some very interesting information, which has from time to time been gleaned from experiments and observations. In Germany, where the study of forestry is considerable, and where any experiments for procuring the welfare and preservation of trees are treated with great importance, the investigations on the point now under consideration have a very practical object, for great damage must be yearly done by the storms which occur there during the summer months. The work to which reference is here chiefly made is that of Dimitrie Jonescu,[2] and his observations are based on close observation in the field and experiments in the laboratory. The knowledge that we thus obtain contrasts strikingly with that previously attained, which was founded, for the most part, on conjecture and hearsay.

It has long been known that lightning seemed to have a special fascination for certain kinds of trees, and therefore preferred to strike these rather than others. We have been informed, for instance, that the laurel was seldom if ever struck; while the oak, on the other hand, was the tree which, above all others, was signalled out for this purpose. We do not mean to say, however, that other trees are never damaged in this way, for all are to a more or less extent: but it seems that, in consequence of an unknown reason, preference is given to some more than to others.

A study of this question therefore, if it is to be

[1] *Himmel und Erde* for Jan. 1896.

[2] "Uber die Ursachen der Blitzschläge in Bäume" in "Jahresheft des Vereins für Vaterländ. Naturkunde in Württemberg," 1893, S. 32-62.

thoroughly well undertaken, must not be restricted simply to the species of tree, but should include the conditions of their position and surroundings, such as soil, moisture, &c., as these may play an important part.

The only operations, as far as we know, that seem to have been systematically carried out on these lines, are those which since the year 1874 have been made by the fürstlich Lippe-Detmoldschen Forstdirektion.

The statistics show that from 1879 to 1890 lightning had struck 56 oaks, 3 or 4 pines, 20 or 21 firs, but not a single instance of a beech tree was recorded. These facts will be seen to be of importance when it is stated that the relations between the numbers of different kinds of trees in the region under observation were such that, out of 100 trees, about 70 were beech, 11 oaks, 13 pines, and 6 were firs. The numbers show at a glance that beech trees seemed to have been entirely free from attack, although they were twice as numerous as all the other trees put together. A practical hint can at once be deduced from this; for protection against lightning, when one is in, perhaps, a wood, can be apparently secured, provided of course there are beech trees there!

In the investigation of the underlying causes, it was considered unnecessary to take into account the nature of the soil, for observation showed that trees situated on wet ground were very often struck, thus contradicting the generally conceded idea that this only occurred when they were on soil which contained a very small amount of water. Further, it was also difficult to trace any connection between the different depths to which the roots of trees extended, since this is a subject about which very little is known, and no statistics are at hand for trees that have been thus damaged.

The next step was to consider the species of tree, and investigate whether any facts here might be brought to light. With this point well in mind it was necessary, first, to determine the degree of conductivity of the different kinds of wood. Experiments in this direction have previously been made by Du Moncel, but his observations, for many reasons, gave very variable values, so variable in fact that he himself could not lay any weight on them.

One fact known, with regard to the conductivity of different species of wood by the help of the electric spark, is that electricity is conducted better in the direction of the grain than in the direction perpendicular to it. Further, Caspary has shown, in the case of lime- and dry pine-wood, that conductivity varies according as the direction is longitudinal, radial, or tangential.

Notwithstanding the results just mentioned, Jonescu[1] undertook the work afresh, and made independent observations, employing the electric spark throughout, and taking into consideration the anatomical, chemical, and physiological properties of the different kinds of wood.

It will be sufficient for us to deal simply with the results of these investigations, without entering into the method of experiment adopted.

The first experiments with oak and beech indicated that the former was a very much better conductor than the latter, just as appeared to be the case from the statistics given above, if conductivity be assumed to play the most prominent part. Similar experiments were made with black-poplar and willow. With living wood—that is, wood just cut, and therefore containing moisture—the percentage of the latter being, according to Schübler and R. Hartig, for black-poplar 51·8, beech 39·7, oak 35·4, and willow 26·0, experiments led to the result that conductivity of wood in this state is independent of the amount of moisture inside.

[1] Berichten der Deutschen Botanischen Gesellschaft. Bd. xii., 1894, S. 129-136.

Extending the observations over a far wider range, and employing numerous different kinds of woods containing varying quantities of fatty materials, such as oil and resin, it was discovered that the wood cut from living trees was in every case a worse conductor of electricity the more oil or resin they contained. The fresh wood of trees, on the other hand, which are rich in starch but poor with regard to fatty matter, conducted electricity very well, although no large difference for the various kinds of wood was noticed.

It will thus be seen that the question under consideration seems to reduce itself to the finding out the qualities of the juicy matters in the wood of the trees, as these seem to play an important, if not the whole, *rôle* in the proceedings.

As regards the distribution of the fatty materials and the starch in the wood of trees, we have to apply to Fisher and Suroz, who, from their investigations on these points, have shown that the quantity of oil and starch varies with the time of year; they have, further, classified trees according to their richness in these materials.

According to these facts then, assuming in the case of Germany that it is during the summer months that thunderstorms are most frequent, those trees rich in fatty materials (Fettbäume), and which during the summer contain much of them, are to a great extent protected against lightning. Those, on the other hand, that are poor in oil during the period of thunder-storms, and especially such trees which contain much starch (Stärkbäume), are more liable to be struck.

One very interesting example to which reference is made is the wood-pine. This tree, during the summer months in Germany, is, comparatively speaking, very often damaged, while in countries where the thunderstorms occur in the winter months (Ireland and Norway) it is usually untouched. To explain this according to the deductions of Jonescu's observations, it must be shown that in winter the tree is richer in oil than in summer. A microscopic examination of samples at both these periods of the year has proved conclusively that this is really the case, the oil disappearing in April, to have its place taken by glucose and starch. Employing the apparatus previously referred to, Jonescu found that for the winter wood of this tree double the amount of potential energy was required for sparking purposes than was required when operating with the summer wood.

As a check on his own results, Jonescu took the wood of typical trees rich in fatty materials (Fettbäume), beech and walnut, and found that when deprived of their oil by means of ether, their degrees of conductivity were increased and became practically the same as those of the wood of typical trees rich in starch (Stärkebäume).

The above explanation of the causes which render some trees more than others liable to the destructive power of a lightning flash, helps certainly to explain other points of less importance. Experiment showed that for both kinds of trees, namely, those rich in fatty materials and starch respectively, the wood in the living state is a far worse conductor than when dead. This leads to the deduction that trees with dead branches on them are more likely to be struck than those without any, so that they should be avoided if possible. Jonescu's hypothesis also explains why it is that lightning does not as a rule strike the highest part of a tree, but generally the trunk, either inside or underneath the crown.

In conclusion, it is to be hoped that these investigations of Jonescu, to which only brief reference here has been made, will be followed by observations and statistics from other sources, for this question is one that is of very general interest. It is sad to think, however, that the oak, a tree which we cherish so much, is such a friend to flashes of lightning in the way of conduction, that it in this way brings on its own destruction. D.

THE GREAT MADRID METEOR.

ON Monday, February 10, at 9h. 29m. 30s., there was observed an instantaneous bluish-white illumination in the atmosphere, so strong and vivid as to be visible in the inner rooms and in the open air.

The day was a magnificent one: blue sky, no wind, and a radiant sun.

Soon after there was plainly visible near the zenith, and some few degrees to the south-east, a white spot, like smoke, bearing north-east to south-west, of about 6° length and 1° wide; its form was semicircular, with the convexity turned to the east. In the centre, and near the apex of the curve, it presented a condensation of a reddish colour, similar to those of clouds at sunset. The general appearance of the spot was that of a light cirro-cumulus.

At 9h. 30m. 40s. there was heard a deep and very strong detonation, accompanied by many others not so intense, similar to the noise produced by a large cannon-ball running along the upper storey of a house. This noise was very prolonged; it was found to last two minutes.

Meanwhile the vibration of windows and partitions (not the thick walls) was extraordinary, and the rattling of panes of glass alarming. In some houses all the window-glasses were broken.

Judging from the time which elapsed between the light and the sound of the first detonation, the meteor exploded in the air at a distance not inferior to 24 kilometres; and this number is evidently too low.

Considering the aspect of the spot of smoke, it seems probable that the meteor proceeded from the south-east towards the north-west, and that near the zenith of Madrid it exploded.

Changed into smoke and dust, totally or partially, this smoke was carried away by the superior currents of the atmosphere to the east. We find here a splendid confirmation of the theory which supposes that, at the upper limits of the air, the wind moves from west to east.

In the accompanying rough sketch, one part corresponds to the trajectory of the celestial body; and the other, which forms an angle with the first, to the action of the aerial current.

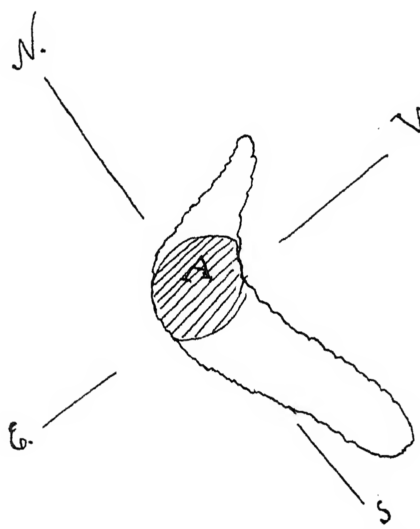


FIG. 1.—Aspect and position of the cloud some minutes after the explosion. A, Condensation of a reddish colour.

The accompanying photograph of the phenomenon was taken by an amateur some few minutes after the explosion.

The cloud continued its course to the E.N.E., or E. ¼ N.E., dissolving gradually away, and at 3h. p.m. it was still perfectly visible like a light cirrus in the east at some 20° above the horizon.

The compression of the atmosphere in the instant of the conflagration was indicated by the registering barometers. In the aneroids the trace is small; but in the mercurial one the column rose 1·6 m.m., and lowered 0·7 m.m., the amplitude of the total oscillation being 2·3 m.m.

In the neighbourhood of Madrid some fragments of the meteor fell, and I have obtained one of them.

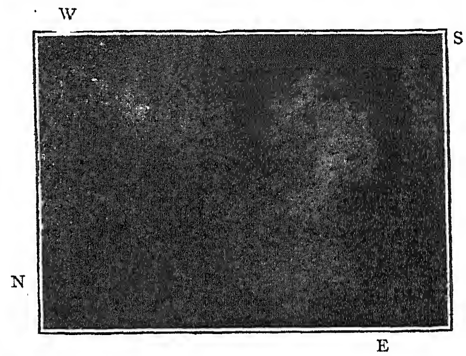


FIG. 2.—Photograph of the cloud immediately after the explosion.

Externally the fragment is of a black metallic aspect; inside it is of white stony appearance, with some brilliant points like nickel; it weighs 6·3 grams.

From information received later, it appears that the phenomenon was visible in a large part of the Peninsula, from Sierra de Estrella (Portugal) to Denia in the Mediterranean coast, and from Segovia to Aguilas, or a distance of 700 kilometres from east to west, and 400 from north to south. These are inferior limits.

AUGUSTO ARCIMIS.

THE FRILLED LIZARD: "CHLAMYDOSAURUS KINGI."

THE above-named lizard inhabits the northern or tropical territories of the Australian continent, and is tolerably abundant in both North Queensland and the Kimberley district of Western Australia. Its earliest record is that given by Captain Philip P. King, in his "Narrative of a Survey of the Intertropical Coasts of Australia" (1826), and wherein it is named, figured, and described in a Natural History Appendix by Dr. J. E. Grey.

The habitat of the frilled lizard is essentially sylvan, its resort being the thickly-wooded scrublands, and its favourite abiding-place the trunks and lower limbs of the larger trees. The length of the finest examples rarely exceeds three feet, and of this the long, rough, though slender tail monopolises the greater moiety. Living specimens exhibit a considerable individual colour variation. The predominant hue of the body is pale brown with reticulated markings; while the frill, in the males more especially, is usually decorated with interblending tints of yellow, scarlet, and steel-blue.

No living example of this singular lizard had, up to the present year, been brought alive to Europe, a circumstance which will account, to a large measure, for the fact of certain abnormal phenomena connected with its life-habits having hitherto attracted little or no scientific attention. Through the possession of living specimens of *Chlamydosaurus* in both Queensland and Western Australia, several interesting data concerning the species have fallen within my notice. Having, furthermore, succeeded in bringing one out of several examples embarked safely to England, my presentation of the animal to the

Zoological Society's Gardens, where it was on view for some weeks, has afforded many fellow-naturalists the opportunity of verifying the phenomena here recorded.

The most conspicuous structural feature of *Chlamydosaurus kingi* is the extraordinary development of the cuticle of the neck, that gives to it its popular title. This takes the form of a voluminous frill or collar, which, while the animal is at rest or undisturbed, is neatly folded in symmetrical pleats around the creature's neck and shoulders. No sooner, however, is the lizard excited to hostility by the approach of a threatening assailant, than, coincident with the opening of the mouth, the frill is suddenly erected, much after the manner of the unfurling of an umbrella, and stands out at right angles to the longer axis of the body, measuring under such conditions some seven or eight inches in diameter.

The mechanism by which the erection and depression of the frill of *Chlamydosaurus* is accomplished is intimately connected with a slender process of the hyoid bone, which traverses the substance of the frill on each side, and is so adjusted that the opening of the creature's mouth and the erection of the frill are synchronous operations. A characteristic photograph from life of this lizard in a condition of excitement, and standing at bay, with mouth open and frill erect, is afforded by Fig. 1, representing one of many I was fortunate in securing from the specimen I brought to England.

The function of the frill in *Chlamydosaurus* is, as apparently indicated by the circumstances and conditions under which alone it is displayed to view, purely that of a "scare-organ," wherewith by its sudden expansion many of its would-be assailants are frightened and deterred from attacking it. Instances have, in fact, been recorded to me of dogs, which will readily rush upon and kill other and larger lizards, such as *Varani*, refusing to come to close quarters with so formidable-looking an object as *Chlamydosaurus*, when it turns upon them with gaping mouth and suddenly erected frill.

Chlamydosaurus displays, however, additional defensive tactics. When approached these lizards will often spring aggressively at the intruder, and in addition to using their not very formidable teeth, will lash sideways with their long rough tails with such vigour as to smartly sting the hand which may fall within range of the unexpected impact.

The natural food of the frilled lizard consists almost exclusively of Coleoptera and other bark-frequenting insects; a fact which emphasises the difficulty of keeping them long in a state of captivity. The several specimens in my possession became fairly accustomed to dieting on raw meat, though they would not take to this artificially substituted pabulum voluntarily. On the slightest excitement, however, they would open their mouths and erect their frills, and on which occasions it was a simple matter to administer pieces of meat, which were then readily assimilated.

The most remarkable feature placed *en evidence* by the specimens I kept in captivity, was their peculiar method of perambulation. The statement that the frilled lizard was in the habit of running erect on its hind legs only, was made to me in Queensland some years ago. I failed, however, to verify this assertion through the single living specimen I there had in captivity for a short interval; and neither was a friend in the northern district of the colony more fortunate, who, at my request, made experiments with several specimens. I was, on these grounds, inclined to suspect that the rumour, that had previously reached me, was the outcome of an optical illusion; many lizards, such as *Grammitophoræ*, running so erect on their haunches that it might be imagined their fore-limbs were raised from the ground.[1]

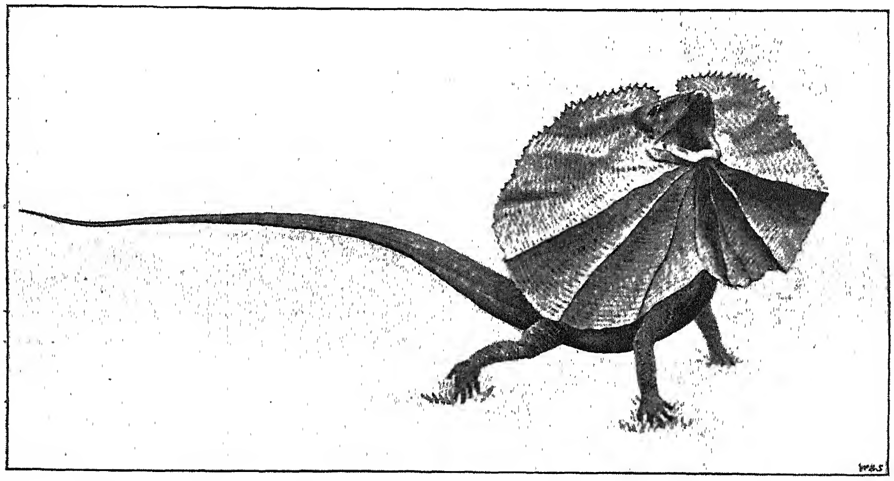


FIG. 1.—*Chlamydosaurus Kingi*, standing at bay with erected frill. (Reproduced from an instantanous photograph by W. Saville-Kent.)

It was consequently to my no small gratification and delight, on becoming the owner of several specimens, including the one brought to England, obtained for me with the assistance of the aborigines of Roebuck Bay, Western Australia, that I found myself in a position to fully establish the truth of the report concerning the erect gait of *Chlamydosaurus* that had been communicated to me in Queensland. Possibly the specimens previously experimented with had been slightly injured during capture, and lacked the stamina to walk upright. At all events the Roebuck Bay examples, brought in straight from the bush, were in vigorous health, and at the first trial when left at liberty, save for a light retaining cord, ran along the ground almost perfectly erect, with both

[1] It has quite recently come to my knowledge that a report of the bipedal comportment of *Chlamydosaurus* was communicated some years since to Dr. Henry Woodward, F.R.S., who referred to the circumstance in a paper on "Forms Intermediate between Birds and Reptiles" in the *Quart. Journ. Geological Society*, vol. xxx. 1874, The concluding paragraph of that paper, wherein Dr. Woodward favours the interpretation that "the bipedal habit of the secondary reptiles is a peculiarity still maintained by the Australian *Chlamydosaurus*," is of special interest with relation to the latter portion of this article. The assertion made by Dr. Woodward's informant in the journal quoted, that *Chlamydosaurus* is common near Sydney, is a mistake due, probably. to the circumstance that another lizard, *Amphibolurus barbatus*, having a less developed neck-membrane, inhabits that district, and is sometimes also known locally as the Frilled Lizard. The structure of this type, however, would not permit of its bipedal progression.

their fore-limbs and long tails elevated clear of the ground.

The attempt was made on the spot to permanently register, with the aid of the Kodak camera, the absurdly grotesque appearances these lizards presented when progressing in this bipedal fashion. Such, however, was the speed at which the animals ran, that the shutter of that instrument did not work fast enough to secure anything better than a blur at close quarters, and it was only by bringing an Anschutz camera with its most rapid roller-blind shutter to bear on the specimen, after its arrival in London, that the Figs. 2 and 3, here reproduced, were secured. While even these partake much of the nature of silhouettes, they will serve to indicate the more characteristic running attitudes which this lizard may assume.

Fig. 2 in this series carries with it so essentially human an aspect that one is sorely tempted, at the risk even of incurring scientific contumely, to place a cricket-bat in its right hand. The distance *Chlamydosaurus* will traverse in this remarkable erect position may average as much

FIG. 2.—*Chlamydosaurus* running erect. Posterior view, taken with Anschutz hand camera

as thirty or forty feet at a stretch, and when, after resting momentarily on its haunches, it will resume its running course. When, however, a short space of a few yards only have to be covered, the animal runs on all-fours, sitting somewhat high on its haunches after the manner of many ordinary lizards, such as the *Grammitophoræ*, previously referred to.

The profile outline of *Chlamydosaurus*, presented by Fig. 3, is peculiarly interesting, since it possesses so much in common with that of a running long-tailed bird, such as a pheasant. This bird-like aspect of the frilled lizard, as exhibited when it crosses the observer's path in bipedal fashion, has been the recent subject of remark to me by a friend familiar with the species in the Kimberley district of Western Australia.

Special interest is attachable to this avian-like ambulatory deportment of *Chlamydosaurus* by reason of the generally accepted interpretation that the birds are modified descendants of a reptilian archetype. The temptation is naturally also very great to institute comparisons between, and to suggest possible affinities with, this peculiar lizard and the extinct group of the Dinosauria, and among whose representatives a bipedal locomotive formula was apparently a characteristic feature. A reference, however, to the skeleton of *Chlamydosaurus* does not encourage any sanguine anticipations that may have been previously entertained in this direction. It yields no indication of that peculiar avian modification of the pelvic elements, adapted for bipedal locomotion, that are so essentially diagnostic of the more typical Dinosauria, while in all general points it is indistinguishable from that of the ordinary Agamidæ.

Though, as a consequence, no serious attempt would be justified to correlate the erectly progressional *Chlamydosaurus* with such ponderous specialised Dinosaurs as, say, *Iguanodon* or *Brontosaurus*, there are some few species at the lacertilian end of the chain, that probably presented when living, a by no means remote likeness to this existing type in both aspect and gait. The *Compsognathus longipes* of A. Wagner, from the lithographic stones of Solenhofen, is more especially worthy of mention in this connection. In size, some three feet long only, and in the proportions of the limbs and other points, it must have been almost a counterpart of *Chlamydosaurus kingi*. It is particularly noteworthy of it, moreover, that, as pointed out by the late Prof. Huxley

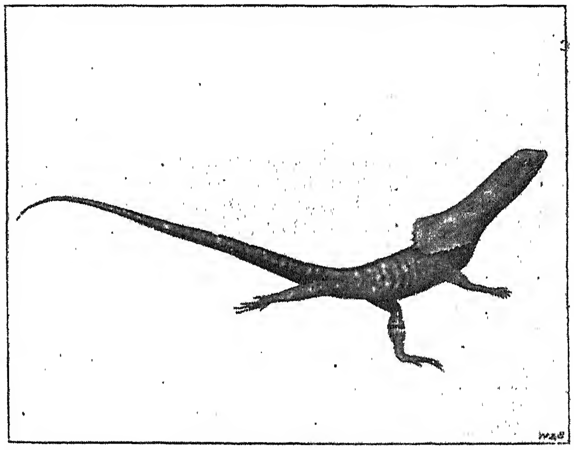


FIG. 3.—*Chlamydosaurus* running erect. Profile view.

("Anatomy of Vertebrata," p. 262, ed. 1871), the pelvic elements of *Compsognathus* correspond more essentially with those of the ordinary lizards than with those of the aviform Dinosauria, the pubes in particular being apparently directed forwards and downwards, like those of lizards. This type, as likewise *Stenopelyx*, is also referred to by the same authority (p. 263) as indicating that the more typical modification of the pelvis, and in which the pubes are directed backwards parallel with the ischia, as in birds and Iguanodon, "was by no means universal" among the Dinosauria or Ornithoscelida, as Prof. Huxley preferentially named them.

Notwithstanding the distinctly recognised lacertilian character of the pelvis of *Compsognathus*, Prof. Huxley had no hesitation in assigning to this type an erect bipedal method of locomotion. Writing of it in the *Popular Science Review*, 1866, that illustrious biologist remarks: "It is impossible to look at the conformation of this strange reptile, and to doubt that it hopped or walked in an erect or semi-erect position after the manner of a bird, to which its long neck, slight head, and small anterior limbs must have given it an extraordinary resemblance."

The silhouette presentment of *Chlamydosaurus* afforded by Fig. 3, forms a not inapt embodiment of the flesh-clad

skeleton that must have suggested itself, ghost-like, to the learned Professor's mind. And it is among my keen personal regrets for the loss the world has sustained through the decease of Prof. Huxley, that I should have been deprived by so short an interval of gladdening my former teacher's eyes with the sight of a living organism which, if only in the direction of superficial analogy, so nearly realised one, among the many, of his most sagacious interpretations of the fossil past. One remaining point in the erect running gait of *Chlamydosaurus* invites brief attention. Such is the conformation of the hind foot and its component digits, that when thus running the three central digits only rest upon the ground. As a consequence of this structural peculiarity, the tract made by this lizard when passing erect over damp sand or other impressible soil, would be tridactyle like that of a bird, and would also correspond with such as are left in Mesozoic strata by various typical Dinosauria. This tridigitigrade formula of the gradation of *Chlamydosaurus*, induced by the great relative shortness of the first and fifth digits, is distinctly indicated in the second of the accompanying figures.

Whether or not the bipedal locomotive comportment of *Chlamydosaurus* has been transmitted by heredity from a lizard-like Dinosaurian such as *Compsognathus*, or has been re-developed independently among its allocated family group of the Agamidæ, is a question concerning which, I humbly recognise, it would be unbecoming temerity on my part to pronounce a verdict. The phenomenon, while dominant among the Reptilia of bygone ages, is, with the exceptional instance afforded by *Chlamydosaurus*, extinct among living types, and is, on that account alone, of unique interest.

Without overstepping the bounds of prudence, it may be finally suggested that the occurrence within the Australian region, embracing New Zealand, of such a wealth of archaic types such as the mesozoically related lizard *Hatteria* and the fresh-water fish *Ceratodus*, as also a dominant mammalian fauna that pre-existed, but is now extinct, in other continents, would justify the anticipation that a reptile inheriting the phenomenal habits of a Mesozoic race might be sought for with the greatest prospects of success upon Australasian territory.

W. SAVILLE-KENT.

NOTES.

THE list of Presidents for the ten Sections of the British Association, for the Liverpool meeting in September next, has been published. All the Sectional Presidents having accepted the nominations, the list may be regarded as definitive. President of the Association—Sir Joseph Lister, Bart., P.R.S. Section A—Mathematics and Physics, Prof. J. J. Thomson, F.R.S. Section B—Chemistry, Dr. Ludwig Mond, F.R.S. Section C—Geology, Mr. John Edward Marr, F.R.S. Section D—Zoology, Prof. E. B. Poulton, F.R.S. Section E—Geography, Major Leonard Darwin. Section F—Economics, Right Hon. Leonard Courtney, M.P. Section G—Mechanical Science, Sir Charles Douglas Fox. Section H—Anthropology, Mr. Arthur Evans (Keeper of the Ashmolean Museum, Oxford). Section I—Physiology and Pathology—Dr. Walter Holbrook Gaskell, F.R.S. Section K—Botany, Dr. D. H. Scott, F.R.S. Evening discourses will be given by Prof. Flinders Petrie and, probably, by Sir Andrew Noble. The lecture to working men will be given by Prof. Fleming, F.R.S.

THE Toronto Local Committee are assiduously engaged in preliminary work for the meeting of the British Association for the Advancement of Science in 1897. Meetings of the executive committee are held every fortnight. Besides the executive committee, a number of sub-committees are at work, including those on finance, conveyances, publication and printing, rooms for offices, meetings of the association and committees, hotel and lodgings, press, hospitality, reception, and for securing co-operation of other institutes, associations, and corporations, postal, telegraph and telephone facilities. The attention of the committee on conveyance has already been called to the desirability of securing from the Canadian Pacific Railroad transportation for such members of the Association as may desire to extend their travels to the Pacific coast, with special reference to the suggestion that a meeting of the American Association for the Advancement of Science may follow the Toronto meeting, if adequate facilities for transportation are assured. This suggestion is based upon the fact that the American Association have already once voted in favour of such a meeting if satisfactory rates could be obtained; and the hope is still entertained that delegates from both British and Australasian Associations might find San Francisco a convenient point at which to meet the American Association. Mr. Griffith, the general secretary of the British Association, is expected to be in Toronto about May 22, to make arrangements for the meeting, and set out the proper lines of work.

FROM McGill University, Montreal, comes the information that Röntgen's experiments were not only repeated there with considerable success immediately on the announcement of his results in America, but have been applied to two important medical cases within the first week of their demonstration. Before any full description of Röntgen's method had crossed the ocean, Prof. Cox was enabled by a lucky guess, and with the aid of the fine McDonald apparatus, to reach success at the first attempt. Four days later a photograph was obtained, clearly showing the bones of the leg from the knee downwards, with the image of a bullet (which had been there for seven weeks and was causing trouble) clearly defined between the two bones, and resting against the inner angle of the tibia. The same photograph showed a copper wire which had been bound round the leg as a fiducial mark from which to measure. The bullet was six centimetres below the wire. On the following day the bullet was reached at a depth of two inches, and was extracted successfully. The exposure required for this photograph was forty minutes. The Pulüj tube (Geissler Catalogue 3080) has been found by Prof. Cox to be superior to any others tried. Its fluorescing screen seems to protect the glass, and is far brighter than that of the other tubes. It gave continuous exposures of 65 minutes without injury, and has since been used to detect a fracture of the ulna, and to produce a photograph of the hand, with perfect definition.

OUR U.S. correspondent writes under date February 14:—"The new photography continues to be the absorbing topic in scientific circles, and innumerable experiments and results are reported. Dr. Henry W. Cattell, of the University of Pennsylvania, has taken pictures of anatomical preparations with such success, that he infers it will be easy to obtain pictures of acromegaly, osteitis deformans, rheumatoid arthritis, &c. Prof. W. F. Magie, of Princeton, has invented a new instrument for use in diagnosis. A sheet of black paper, coated on one side with barium platino-cyanide, is placed with the coated side inward across the end of a tube or box, into which the observer looks, and which is so fitted to the face, or so shielded by cloths, that the phosphorescent substance and the eyes are protected from all extraneous light. If the tube be then directed towards the excited Crookes' tube giving the Röntgen rays, the phosphorescent paper in the tube glows, and the shadows of objects interposed between it and the Crookes' tube appear upon it. The first successful experiments in Brooklyn are by Prof. William C. Peckham, at the Adelphi Institute, using more direct methods than have heretofore been used, with a current of $3\frac{1}{2}$ amperes and an electrical pressure of six volts. Dr. A. Mau succeeded in

obtaining a photograph of a key, covered by a board, by five hours' exposure to direct sunlight. Elaborate experiments are in progress at Columbia, under the direction of Profs. Rood, Papin, and Hallock, with a prospect of important results."

WITH reference to the report that Prof. Salvioni had discovered how to make directly visible the bones of the hand by means of Röntgen rays, the Rome correspondent of the *British Medical Journal* says:—"At a meeting of the Perugia Medico-Chirurgical Society, held on February 5, Prof. Salvioni, teacher of physics at the University, made a most important communication on the new results obtained by him in Röntgen's rays. In studying the question, his aim was to invent an apparatus which would enable one to see direct and without the intervention of photography certain bodies enclosed in wood, flesh, cardboard, &c. He therefore studied the possibility of rendering the retina sensitive to Röntgen's rays. In this he has succeeded by inventing an apparatus which he has called a cryptoscope, which he exhibited at the meeting, and by means of which one can clearly see the contours of the bones of one's own hand, objects enclosed in cardboard boxes, leather purses, &c. This apparatus is very simple, and consists of a black cardboard tube enclosed at one end with a disc of black cardboard coated internally with a fluorescent substance (barium platino-cyanide, sulphate of calcium, &c.); in the other end is placed a lens which permits one to clearly see the fluorescent surface. The object to be observed is placed before the luminous source given by a Crookes' tube, and then one looks at it through the cryptoscope placed at a suitable distance. As in the fluorescent cardboard the parts of the object impermeable to Röntgen's rays are drawn in shadow, thus one clearly sees the contours of the bones of the hand, &c. A model of the instrument was made under the direction of Prof. Blasema at the Physical Cabinet of the Roman University on February 11, and with it one could clearly see the bones of one's own hand, coins in a purse or the clenched hand, &c. It is evident from these results that the apparatus, when perfected, will be of great use in medicine and surgery."

THE current number of the *Comptes rendus* contains no less than seven papers bearing on the Röntgen rays. In following up the analogy of certain properties of these rays with some properties of the ultra-violet rays, M. R. Swyngedauw has found that the X-rays cause a lowering of the explosive potential according to the same general laws as the electrically active ultra-violet rays. Whilst the influence of the latter, however, is entirely suppressed by interposing a screen of wood, glass, or blackened paper, these materials do not affect this property of the Röntgen rays. It was also noticed that these rays lowered the dynamic explosive potentials to a greater extent than the static potentials. As a result of the study of the property of the Röntgen rays of discharging an electrified body, M. A. Righi concludes that the time necessary for a given fall of potential is practically the same, whether the original charge be positive or negative. With an initial positive charge the discharge is not complete; but if negative initially, not only is the discharge complete, but the disc becomes positive. The results obtained by MM. J. J. Borgman and A. L. Gerchun, however, are precisely contrary to these, a positively charged disc losing its charge nearly instantaneously, and becoming negative on prolonged exposure to a Crookes' tube. MM. L. Benoist and D. Hurmuzescu contribute further researches on the same subject of a quantitative character. By measuring the time required for a given reduction of angle between the leaves of an electroscope, and the distance of the leaves from the Crookes' tube, they prove that the ratio of the times are as the ratio of the squares of the distances. From the coefficient of transmission (0·85) of an aluminium plate, 0·1 mm. thick, it is shown that a plate of aluminium 15 mm. thick, such as was used by Röntgen in his original experiments, must be practically opaque to the rays *unless the rays are heterogeneous*. In an extract from a letter by M. de Heen, an ingenious experiment is described which proves conclusively that the X-rays proceed from the anode, and not the kathode. A leaden plate perforated with holes is placed between the Crookes' tube and the photographic plates, and the direction of the bundles of rays thus obtained shows clearly that these rays are anodic.

DR. M. ARMAND RUFFER has resigned the post of Director of the British Institute of Preventive Medicine, and has been appointed Professor of Bacteriology at the Medical School of Cairo, vice Dr. Kaufmann, resigned.

COLONEL C. F. CROCKER, a member of the Regents' Committee of the Lick Observatory, has undertaken to pay the expenses of an expedition which will be sent from the Observatory to Japan to observe the forthcoming solar eclipse. The expedition will be under the direction of Prof. Schaeberle, and its programme will be wholly photographic.

CHARLES WACHSMUTH, well known as a palæontologist in the line of Crinoids, died suddenly at Burlington, Iowa, February 17, aged sixty-six years. He was a native of Germany, and had spent forty years in scientific research among the Crinoids of the Mississippi Valley and the Tennessee Mountains.

THE deaths are announced of Prof. J. Graindorge, Professor of Mathematical Physics and Kinematics at Lüttich; M. Abel Hovelacque, the distinguished Anthropologist and Orientalist, at Paris; Dr. K. Stölzel, Professor of Technical Chemistry and Metallurgy in the Technical High School at Munich; Dr. P. Hedenius, Professor of Pathology and Pathological Anatomy at Upsala.

THE progress in electric propulsion appears in many ways. Electric motors have been tried and will be substituted for steam on the New York and Brooklyn Bridge as a means of switching trains at the termini, thus practically doubling the capacity of the bridge. A Westinghouse system railroad locomotive, the first one constructed, has just been completed at Philadelphia, and sent to Pittsburgh for its electric equipment. A speed of 200 miles an hour is claimed. Experiments indicate that electricity will soon supplant steam as a motor on the entire New York elevated railroad system.

. THE following prizes have recently been awarded by the Académie Royale de Belgique: M. J. Verschaffelt, 600 francs for his work on the determination of molecular weights of bodies in solution; M. E. Haerens, 1420 francs (Prix Charles Lemaire) for the best treatise on public works. The following have been elected Foreign Associates of the Academy: Profs. Sylvester (Oxford), Cannizzaro (Rome), Strasburger (Bonn), Cope (Philadelphia), M. Marey (Paris), and Sir Archibald Geikie (London). M. Fraipont (Liège) has been elected Correspondant in the Natural Science Section.

ALL who are working for the reform of our system of weights and measures will be interested to know that the Swiss Government have recently invited the countries parties to the Berne Convention—in other words, all the leading countries of the continent of Europe—to a conference to discuss *inter alia* the introduction of a uniform gauge of screws based on the metric system. Mr. W. M. Acworth remarks in the *Times* that, according to the official document, this gauge is intended to take the place of the "so-called Whitworth system, based on English measures, which is at present in use under various forms." It is pointed out that there is an immense advantage in having the material for the repair of rolling-stock, which often travels

thousands of miles from home, interchangeable. It is added, moreover, that, if the way to this reform be once opened under the lead of railways, private manufacturers may be confidently expected to promptly follow suit.

THE spring meeting of the Iron and Steel Institute will be held in London, at the Institution of Civil Engineers, on May 7 and 8; and the autumn meeting will be held at Bilbao at the beginning of September, under the presidency of Sir David Dale. Special arrangements are being made for the autumn meeting, the programme for which will include visits to the important Spanish mines, from which so large a proportion of the iron ore used in Great Britain is obtained. Owing to the limited hotel accommodation at Bilbao, arrangements are being made to secure one of the Orient Company's steamers to convey the members to Bilbao and back, and to serve as a floating hotel. It is proposed that the cruise should last a fortnight, and that calls should be made at some of the Spanish and French watering-places.

IN a letter to the *Times*, Admiral Richards briefly reviews Dr. Nansen's expedition and the report of its having reached the North Pole. It will be remembered that Nansen's intention was to place his ship in the solid ice off the coast of Siberia and to drift with it across the Pole into the Greenland Sea, believing it would be carried there by a current. Admiral Richards points out, however, that in the Polar basin proper it is doubtful if the ice ever finds an exit. The ships which entered on its confines in Wellington Channel found it blocked there; M'Clure also found it blocked between Banksland and Melville Island. Nares could not get a mile north from the top of Smith Sound for very heavy ice, and the only channel it could escape by is the Greenland Sea, of which there is no evidence, while by Davis Strait great numbers of bergs and enormous quantities of ice are constantly passing down in the months of July and August, but none of it from the Arctic basin proper. These facts, remarks Admiral Richards, tell strongly against Nansen's succeeding in his original project, but they need not have been an obstacle in his reaching a certain distance north from the coast of Siberia.

THE anniversary meeting of the Geological Society of London was held on Friday, when Dr. Henry Hicks, F.R.S., was elected President for the ensuing year. The retiring President (Dr. Edward Woodward) delivered his anniversary address, which dealt with the life-history of the Crustacea in later Palæozoic and in Neozoic times. The following awards of medals and funds were made: The Wollaston medal to Prof. E. Suess; the Murchison medal, and part of the proceeds of the Murchison fund, to Mr. T. Mellard Reade; the Lyell medal, and part of the proceeds of the Lyell fund, to Mr. A. Smith Woodward; balance of the Wollaston fund, and part of the proceeds of the Barlow-Jameson fund, to Mr. Alfred Harker; balance of the proceeds of the Murchison fund to Mr. Philip Lake; moiety of balance of proceeds of Lyell fund to Dr. W. F. Hume; moiety of balance of proceeds of Lyell fund to Mr. C. W. Andrews; moiety of balance of proceeds of Barlow-Jameson fund to Mr. Joseph Wright; moiety of balance of proceeds of Barlow-Jameson fund to Mr. John Storrie.

WE understand from the *Lancet* that the arrangements for the next International Congress, which will be held in Moscow in August 1897, are now being worked out by the special Committee appointed for the purpose. There will be twelve sections, as follows: (1) anatomy, (2) physiology, (3) general pathology and pathological anatomy, (4) general therapeutics, (5) internal diseases, (6) children's diseases, (7) nervous and mental diseases, (8) dermatology, (9) surgery and diseases of the eye, (10) midwifery and gynæcology, (11) hygiene, and (12) legal medicine. The Government has assigned 35,000 roubles for the expenses of the congress. The official language of the congress will be the French language, but in the general meetings, of which there will be three, communications may be made in any European tongue. In the sectional meetings only three languages will be admitted—namely, French, German, and Russian. Englishmen must regret that they will be debarred from making communications in their own tongue to the sectional meetings, and that their only opportunity of reading papers in the English language will be in the three general meetings.

THE scientific study of the mental and physical condition of children, carried out by Dr. Francis Warner in connection with a Committee of the Congress of Hygiene, has led to results which claim full consideration. Dr. Warner gave an account of his investigations before the Royal Statistical Society last week. It appears that defective development is more frequent in boys than in girls, and more associated with nervous disorder in the former and with delicacy and dulness in girls. Mental dulness is found much associated with irregular movement and action, especially among boys, showing that physical exercises should form a part of brain culture in school. Dealing with the question of mental dulness, Dr. Warner showed that the want of physical training of the brain appears to be a more frequent cause than defective development of the body. Defective physiognomy and proportioning of the features and parts of the body is often associated with mental dulness, but the occurrence of brain disorderliness, indicated by observable signs, is a more general and direct cause. Both defect in development and nerve disorderliness, either alone or in combination with low nutrition, are much associated with mental dulness. From the facts collected, Dr. Warner has been able to deduce the indications of some of the physical causes of defect of body, defect of brain, and mental dulness. It is to be hoped that it will be possible to continue such research beyond the metropolitan area, and that a commission might be appointed by the Government to consider the many important recommendations on national education resulting from the investigation thus far completed.

THE ancient and familiar process used in the manufacture of linen, and known as the "retting" of flax, has long eluded all endeavours to place it upon a sound scientific basis. Prof. Winogradsky, of St. Petersburg, has, however, recently shown that it is directly dependent upon the action of particular bacteria. Considerable difficulty was experienced in discovering the special microbes responsible for the process, and several different varieties were isolated by means of gelatine plate culture from the retted or fermented flax; but in no case, when inoculated on to sterilised flax, did retting ensue. When, however, portions of retted flax were added to the sterilised flax, vigorous fermentation was set up in from twelve to fifteen hours. In the next series of experiments pieces of sterilised flax were inoculated, placed in tubes containing water, the surface of which was sealed from the air by means of a film of oil. In this manner, after a long series of successive inoculations, a somewhat large, spore-forming bacillus was discovered, which subsequent experiments proved to be the specific microbe responsible for the retting of flax. It was obtained in a condition of undoubted purity by anaërobic cultivation on slices of potato which were rubbed over with chalk, and from these cultures the retting of sterilised flax was accomplished with the greatest ease. Prof. Winogradsky is of opinion that the so-called pectic fermentation, by which is understood the transformation during retting of insoluble pectic substances into soluble, must now be regarded as a fermentation process in the strict bacteriological sense of the word.

IN the *Meteorologische Zeitschrift* for December 1895, Prof. G. Hellmann discusses the yearly period of storms in Europe, with

especial reference to the so-called equinoctial gales. In order not to entirely omit large districts, observations both at stations with and without anemographs have been utilised, and he has deduced the yearly period at some fifty stations; but, partly not to complicate the discussion, and partly from want of necessary details, no account has been taken of the duration, force and direction of the storms. The position of the station has a great influence upon the yearly period; a place with a good western exposure will have more westerly storms than a station with an easterly exposure, and *vice versâ*. The author finds that in the extreme south-west of Europe March is the most stormy month; this is very marked at San Fernando, near Cadiz, where 45 per cent. of all storms occur in that month. Further northwards, on the Atlantic coast, the March maximum gradually recedes; and on the coasts of France, the British Isles, and Norway, there is a decided maximum in January, and at some inland places this also holds good. This agrees with the results obtained by Mr. R. H. Scott for the British Isles (*Quarterly Journal* of the Roy. Meteor. Society, 1884), who showed that mid-winter was the stormiest season. The stations of South Norway and part of North Germany show a considerable increase of storms in October, but there is a great variation in the yearly period in relatively small districts. The author considers that although storms do not preponderate exactly at the times of the equinoxes, the popular theory holds good to a certain extent, that they frequently occur near those seasons; and that if the year be divided into two parts—one of stormy, and one of relatively calm weather—the months of March and October must be taken as the limiting periods, at all events over a great part of Europe.

WE have received an atlas of the "isanomales" and of the lines of secular change of the earth's magnetism, by Lieut.-General Alexis de Tillo. The atlas contains sixteen maps, which give the isanomales and the lines of equal secular change of the declination, dip, horizontal force, vertical force, and total force for the epoch 1859. In addition there are two maps showing the agonic lines for the epochs 1700, 1800, and 1859, and the lines of maximum secular change in declination for the epochs 1745, 1810, and 1859. The author, from an examination of these maps, concludes that with reference to each of the magnetic elements the globe can be divided into two hemispheres by a great circle approximately parallel to the meridians. In one of these hemispheres the values of the magnetic element are greater than in the other hemisphere, and there is a similarity between the general lie of the isanomales (*i.e.* of the lines of equal departure of each element from the mean value of the element along a parallel of latitude) of the several elements. The agonic lines are reproduced on the maps of the isanomales of dip, vertical force, and of magnetic potential. In particular the places at which the declination is zero coincide with the points of maximum or minimum value of these elements along the parallels of latitude. The isanomales of the horizontal force show that in general in those parts of the surface of the earth at which the declination is westerly the horizontal force is less than in the parts of the surface of the earth at which the declination is easterly. An indication of the Siberian oval appears on the vertical force and dip charts, while on the horizontal force and total force charts there is an indication of a similar oval near the Sandwich Islands.

THE belief in the vampire—that is, a spirit which leaves its dead body in the grave to visit and torment the living—is a very ancient and widely-spread superstition. It is startling to find, according to Mr. G. R. Stetson (*The American Anthropologist*, ix. p. 1), that this ghastly belief still persists in Rhode Island, U.S.A. Persons now living claim to have had their life saved from death by consumption by the exhumation, mutilation, and generally the cremation of some member of their families who had died a short time previously. In the same journal, Dr. J. W. Fewkes has a preliminary article on Tusayan Ethno-botany. This is a subject which has not received the attention it deserves, and it would be well if residents in our colonies and dependencies, who have a taste for botany, would preserve the transient plant-lore of our native races.

WHILE the old-fashioned view of igneous rocks as merely accidental and irregular intruders into the regular sedimentary series has been greatly modified by the results of petrological researches, it is not often that it is found possible, from an investigation of rock-structures, to obtain so complete an account of a series of events in a district as Messrs. Holland and Saise have recently done in the Giridih coalfield in Bengal. They show how a liquid rock-magma of highly basic composition was injected as a series of dykes through the rocks of this area at a temperature so high that near the dykes the coal was coked and columnar structure developed in it, while sandstones were so far fused that they came to closely resemble siliceous lavas. This magma was rich in chlorine, as the abundance of apatite in it shows, and from it thermal waters conveyed chlorides in solution to permeate the rocks around. This permeation by chlorides produced marked changes in certain more ancient igneous rocks, so that when at a later stage earth-movements crushing them led to their metamorphism and re-crystallisation, the results of that metamorphism were quite different in the areas where the chloride-permeation had and had not been effected. Where there were no dykes to supply the chlorides, hornblende-schists were produced; in the neighbourhood of the dykes, scapolite rocks were formed. These and other interesting facts are worked out in convincing manner in a paper contributed to the *Records* of the Indian Geological Survey (vol. xxviii. pt. 4).

MR. CHARLES J. JOLY, Fellow of Trinity College, Dublin, is editing an annotated edition of Sir W. Rowan Hamilton's "Elements of Quaternions." The work is now passing through the press.

AN important article on "Venezuela: her Government, People, and Boundary," by Mr. W. E. Curtis, appears in the February number of the *National Geographic Magazine*, illustrated by pictures of La Guayra, and the Valley of Caracas, east and west of the capital.

WE have received the second volume of meteorological data, published by the U.S. Weather Bureau, containing the results of observations made during 1893, and, as a special contribution, the records in detail of temperature, pressure, and wind at Pike's Peak and Colorado Springs.

A SET of thirteen "Laboratory Tables for Qualitative Analysis," drawn up by the Demonstrators in Chemistry of the Owens College, has been published by Mr. J. E. Cornish, Manchester. The tables are printed upon cards apparently intended for use in chemical laboratories, so that students can be drilled in the mechanical operations of analysis.

THE second "Psychological Index," published annually as part of the *Psychological Review*, has just been issued. The index is a bibliography of the literature of psychology and cognate subjects for 1895, compiled by Dr. L. Farrand and Mr. H. C. Warren. To psychologists, this well-arranged and complete list of published books and papers must be invaluable.

A SECOND edition of "The Methods of Microscopical Research," by Mr. Arthur C. Cole, has been published by Messrs. Baillière, Tindall, and Cox. The book is a practical guide to microscopical manipulation, embodying descriptions of many original processes and methods of work. The first edition was

well received, and the second, much enlarged and in great part re-written, will assuredly be just as successful.

A VOLUME has been received containing the results of rain, river, and evaporation observations made in New South Wales during 1894, under the direction of Mr. H. C. Russell, C.M.G., F.R.S. Two new maps of the colony have been introduced into the report, one showing the average monthly temperature in each square degree, and the other showing the temperatures of spring, summer autumn and winter, also the mean temperature for the year, and the highest and lowest temperatures ever recorded in each square degree.

MESSRS. G. BELL AND SONS have published a dainty brochure on the Koh-i-Nur diamond and the celebrated Pitt diamond, reprinted from Mr. E. W. Streeter's "Great Diamonds of the World." Mr. Streeter prints a letter received from Mr. J. Ball in 1882, containing an opinion against the identity of the Great Mogul and Koh-i-Nur diamonds; but he does not seem to have made much use of the detailed history of the Koh-i Nur in relation to the Great Mogul, as told by Prof. Story-Maskelyne in these columns in 1890 (vol. xliv., p. 555).

THE Library Bureau has sent us the first number of this year's "New Book List"—a catalogue of British literature published during January—compiled and arranged by Mr. Cedric Chivers. We have also received a specimen of a card catalogue which has been inaugurated with the list. It is proposed to publish at monthly intervals, and at a low price, a catalogue of new publications, printed on cards. Every book published will be catalogued under the author's name, and full particulars of the book will be printed upon the card. The card catalogue thus constructed should be of great service in libraries and other institutions.

A CATALOGUE of the "Students' Geological Collection" of the Bristol Museum has just been issued by Mr. E. Wilson, the Curator. This is a special collection of the commonest fossils of British formations, and of typical rocks and minerals, which is available, under proper conditions, for actual handling by elementary students. Such a collection must both be a boon to those who use it, and save the general collections from possibility of misuse. As the specimens are carefully selected, and the localities of almost all are given, the list may prove useful as a suggestion for the formation of similar ones elsewhere. From the same source comes the sixth edition of the popular penny guide to the Bristol Museum.

THE Magnetical and Meteorological Observatory of the Royal College of Belen, Havana, has published a pamphlet on the circulation and cyclonic translation of West India hurricanes, which was originally prepared by the late Father B. Viñes for the Chicago Congress. The paper is one of considerable importance upon the subject in question, as the author spent twenty-three years of his life in constant study of the storms in that part of the world. The first section deals with the general laws of cyclonic circulation and the relations of the movements of cirrus and other clouds to the locality of the centre of disturbance. The second part explains at considerable length the laws of the translation of the disturbance in different months, and its rate of travel in various parts of its path. It is well known that the West India hurricanes first advance towards the west, then turn northwards and recurve towards east-north-east or north-east. The rate of progress is found to differ in various parts of the path, and according to different seasons and latitudes. On these important points and their practical application to navigation Father Viñes' long and attentive studies have led to very valuable results. The work is written in the Spanish language.

THE Society for the Protection of Birds reports progress. The total number of members is now 13,134, no less than 1673 names being enrolled during the year 1895. Various are the reasons which result in an increase of membership of the Society. Naturalists join because they desire to prevent the extermination of rare species, many people become members from æsthetic considerations, and others because they have regard for the feelings of birds. The Society mourns a "deplorable outbreak of savagery in female adornment"—to wit, a recrudescence of the feather-wearing fashion, especially a rage for aigrettes. But, apart from this, the Committee reports the existence of a growing desire in the country to preserve its wild bird life. It is certain that in 1895, such signs have been more frequent and unmistakable than in former years. A greater and ever-increasing impatience is felt against the annual massacre, in August and September, of gulls, terns, guillemots, razorbills, puffins, and other sea-birds on our coasts; the shooting of every rare bird, in the interests of private collectors; the wholesale trapping of songsters, 70 per cent. of which perish within a week of capture, by unlicensed bird-catchers; and the use of the pole-trap. We give our support to the remark that last year was astonishingly prolific in ornithological literature, scientific and popular: it is certain that so large a number of books on the bird-life of the British Islands has not appeared in any previous year. These works should have a beneficial influence upon the Society.

THE preparation of metallic carbides in the electric furnace has, as is now well known, led to an easy method for the direct synthesis of pure acetylene, this gas being produced by the action of water upon the carbides obtained from the alkaline earths. But all metallic carbides do not behave similarly towards water; some (chromium, molybdenum, titanium) being unacted upon at ordinary temperatures, others (aluminium, beryllium) giving methane. In a recent number of the *Comptes rendus* (February 10), M. H. Moissan gives a detailed account of the preparation and properties of uranium carbide. This substance, which has the composition $C_3.Ur_2$, does not differ to any marked extent in its general chemical and physical properties from other substances of the same class, except in its reaction with water. This gives rise to a complex series of solid, liquid, and gaseous hydrocarbons. Of these, only the last have been completely examined, the analysis of the gaseous mixture showing hydrogen (13 per cent. to 15 per cent.), methane (78 per cent. to 80 per cent.), and ethylene (5 per cent. to 7 per cent.), together with a trace of acetylene. M. Moissan, remarking on the presence of the hydrogen, points out that this is probably produced by a secondary reaction, the lower oxide of uranium being able to decompose water. The acetylene also is stated to be probably due to the presence of a little calcium carbide as an impurity.

THE researches of M. Guntz, on the preparation of metallic lithium and its nitride, have led to the discovery of a hydride of this metal possessing some remarkable properties. Wishing to heat some lithium in a current of an inert gas, and nitrogen being obviously excluded, some lithium was raised to a bright red heat in a current of hydrogen, when, much to the astonishment of M. Guntz, the whole caught fire and burnt with flame in the tube, depositing a white powder, and leaving no trace of unburnt lithium. On analysis this proved to have the composition LiH, and is noteworthy as giving the maximum weight of hydrogen on treatment with water for minimum weight of substance, one kilogram giving 250 grams, or 2780 litres of hydrogen. It is not deliquescent, and alters very slowly in air, and is stable at a full red heat, thereby differing from the previously known hydrides of the alkali metals. Heated in a current of nitrogen converts LiH into Li_3N.

THE additions to the Zoological Society's Gardens during the past week include a Lion (*Felis leo*, ♂) from Africa, presented by Mr. Rowland Ward; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mrs. Herbert Morris; a Woodlark (*Alauda arborea*); a Whinchat (*Pratincola rubetra*), British, presented by Mr. J. Young; a Black Tanager (*Tachyphonus melaleucus*) from South America, presented by Madame Caté; a Rhinoceros Hornbill (*Buceros rhinoceros*, ♂) from the Malay Peninsula, deposited; two Black-necked Stilt-Plovers (*Himantopus nigricollis*) from South America, a Long-eared Owl (*Asio otus*), two Common Pheasants (*Phasianus colchicus*, ♀ ♀), British, purchased.

OUR ASTRONOMICAL COLUMN.

CASSEGRAIN AND GREGORIAN REFLECTORS.—For some time past, Prof. Schaeberle, of the Lick Observatory, has been experimenting on the applications of these rather neglected forms of reflecting telescopes with the special view of applying them for celestial photography. The field of view in such instruments is darker than in refracting telescopes, and if the mirrors are good, there is every reason to expect that in planetary photography the results obtained by a telescope twelve or fifteen feet in length will be at least equal to those obtained with the most powerful refractors. There is so little published on the theory of the instruments that Prof. Schaeberle has re-investigated the fundamental formulæ, which may be useful to many observers (*Astronomical Journal*, No. 364). In the case of the Cassegrain it is easily shown that the secondary mirror must theoretically be the convex side of an hyperboloid of revolution, while in the Gregorian it must be the concave side of an ellipsoid of revolution; in both cases the axis and focus of the secondary reflector must coincide with those of the primary. If F denote the focal length of the parabolic reflector, H the distance between the centre of the mirror and the secondary focus (being negative when it falls between the two reflectors); the axial radius of curvature of the secondary reflector; L the equivalent focal length of the combination; then, for both forms

$$L = \frac{F}{r}\left\{(F + H) \pm \sqrt{r^2 + (F + H)^2}\right\} \quad . \quad . \quad . \quad (1)$$

$$r = \frac{2LF(F + H)}{L^2 - F^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$H = \frac{r(L^2 - F^2)}{2LF} - F \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

These formulæ refer to the theoretical conditions for perfect definition; in practice, the secondary mirror is so small that for the same value of r, a spherical surface, or a paraboloid, hyperboloid, or ellipsoid, of any eccentricity, gives tolerable images, the size of which may be varied by simply moving the secondary along the optic axis. There will, however, always be a point of best definition; and if this does not give a convenient position for the secondary focus, the eccentricity of the small reflector must be altered by local polishing. The figuring of the secondary mirror is too delicate for direct measurements, and can only be tested in the telescope itself.

WELLS' ALGOL VARIABLE.—Further particulars of the new variable of the Algol type in the constellation Delphinus (NATURE, vol. liii. p. 206) are given in *Harvard Observatory Circular*, No. 5. The observations so far obtained show that its time of minimum, uncorrected for the velocity of light, can be closely represented by the formula J.D. 2412002·5 + 4·8064 E. For nearly two hours before and after the minimum it is fainter than the twelfth magnitude, but it is not yet possible to say how faint it really becomes. The increase of brightness takes place at first very rapidly, but afterwards more slowly, and the full brightness, magnitude 9·5, is reached in about five hours. Numerous photographs indicate that during the four days between the minima, the brightness is sensibly constant. The changes can be explained on the assumption that the star revolves about a relatively dark body, and that it is totally eclipsed at the minimum, the light then, if any, being that of the companion. The conditions are accordingly somewhat similar to those of U Cephei. The new variable is BD + 17° 4367, its R.A. and decl. for 1900 being respectively 20° 33′·1 and + 17° 56′.

THE NEW COMET.—From observations of the new comet, Perrine-Lamp, made on February 15, 16, and 17, the following elements and ephemeris for Berlin midnight have been computed by Dr. Lamp:

T = 1896 January 31·999 Berlin mean time.

$$\left.\begin{aligned} \omega &= 358^\circ\ 38'\ 16'' \\ \Omega &= 208\ \ 36\ \ 29 \\ i &= 155\ \ 30\ \ 15 \end{aligned}\right\} 1896{\cdot}0$$

$$\log q = 9{\cdot}77022$$

	R.A. h. m. s.	Decl. ° ′	Brightness.
Feb. 27 ..	22 59 40 ...	+ 46 8·7	
,, 29 ...	23 54 31 ...	+ 49 49·2 ...	0·9

M. Bigourdan, who observed the comet at Paris on February 16, states that the comet was not then visible to the naked eye, though bright enough to be easily seen in a telescope of 50 mm. aperture. It was observed to be round, about 2′ in diameter, with a diffuse central condensation about 20″ in extent. At the centre of this condensation a small stellar nucleus was occasionally suspected. No tail was visible.

PERRINE'S COMET (1895).—Dr. E. Lamp has drawn our attention to a misprint in the ephemeris of Perrine's comet, given in NATURE on January 23; the declinations throughout should be placed a line lower. Hence our statement last week, that on re-discovery the declination of the comet was a degree in error was unfounded; as a matter of fact, the corrections to the ephemeris were only + 4s. and + 0′·5. The following is a corrected and extended ephemeris:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
Feb. 29 ...	19 46 48 ...	+ 1 55·1 ...	0·12
Mar. 4 ...	46 41 ...	3 0·7 ...	0·11
,, 8 ...	19 46 16 ...	+ 4 6·7 ...	0·10

M. Bigourdan describes the comet as being round, with a diameter of about 50″, and showing a somewhat diffuse nucleus. It is seen with about the same facility as a star of the twelfth magnitude.

MAGNETIC SURVEYS.[1]

ON looking through these two volumes, the first thought that strikes one is that magnetical observations require a great deal of time for reduction and preparation for publication. In the Russian work, this great consumption of time is perhaps to some extent explained by the distance that separates the place of observation from any centre of civilisation, whence the results could be published, and the inevitable difficulties of communication. Perhaps still more is it to be explained by the fact, that several authors have to compile their separate portions under editorial supervision. Still, eleven years does seem a long interval to elapse between the completion of the observations and the distribution of the results to the public. In the Italian work; carried out in the cultured and accessible cities of Italy, six years have sufficed for the reduction and the printing.

This remark must not be construed as expressing any wish to minimise the difficulties that a scientific expedition to the wilds of North-East Siberia must of necessity encounter, or to make light of the dangers that these enterprising officers experienced in their expatriation, cheerfully endured for scientific ends. One disaster that these scientific experts had to undergo may be mentioned, as it illustrates not only the severities under which they were placed, but the readiness of resource with which they remedied the mishaps, far away from trained workmen and mechanical apparatus. On August 6, 1882 (about the time of the Fort Rae Expedition, it may be remarked), when nearing their destination, they experienced a north-east storm of more than an unpleasant character, which carried their craft on to the rocks, and tumbled their apparatus into the water. The chest containing the instruments for observing the magnetic variation at Ssagastyr (Long. E. 8h. 26m.; Lat. 73° 23′ N.) remained some hours at the bottom, before it could be successfully landed,

[1] "Beobachtungen der Russischen Polarstation an der Lenamündung." I. Theil Astronomische und Magnetische Beobachtungen 1882–1884." Bearbeitet von V. Fuss, F. Müller und N. Jürgens. Herausgegeben von Dr. A. v. Tillo, 1895.

"Misure Assolute degli Elementi del Magnetismo Terrestre, eseguite in Italia negli anni 1888 e 1889 dal Dott. Luigi Palazzo." (Roma, 1895.)

and when opened, on September 6, it presented a gruesome spectacle. The magnets were covered with rust, the wood-work was swollen and would not fit the joints for which it was intended, the wires in the eyepieces missing, silvered mirrors spoilt, and other horrors which it can be imagined scientific apparatus would present after such treatment. All the damages had to be remedied on the spot by their own ingenuity, while, to add to their distress, they lost by the upset much of their petroleum, and had to reduce their light. Nevertheless, in the early days of November, all repairs were effected and the instruments ready for work.

The results of the expedition are practically divided into three parts. In the first, which is more especially under the superintendence of M. V. Fuss, are given the description of the method and the results of the observations at numerous stations for the determination of geographical position. These observations have not been made with that rigorous accuracy to which we are accustomed in inquiries that have for their aim the discussion of the variations of latitude. They are rather field observations, made with the sextant, and instruments possessing similar accuracy, and are no doubt very useful in constructing maps of a practically unknown country. In the same way with the longitude determinations, there is no electrical communication between these places, of which Jakutsk is possibly the only one that would be recognised by the ordinary English reader. A few box chronometers were carried from station to station to determine the difference of local time. Moon culminations and occultations were also employed, and, strange to say, eclipses of Jupiter's satellites. Nothing is said about the errors of the tables or the corrections that have been applied to remove those errors, but the results agree fairly well with other methods. Possibly those observations only have been used, which coincided with others made in a known longitude; but since the whole chain is made to depend for absolute longitude on that of a station at Jakutsk, determined on the occasion of the eighteenth century transits of Venus, and now unrecognisable, they do not probably interfere much with the final accuracy. The outcome of the inquiry is to give us more or less trustworthy positions of some twenty-four stations ranging between 8h.-9h. east longitude from Greenwich, and from 60°-74°, north latitude.

In the next section, under the superintendence of MM. N. Jürgens and F. Müller, are presented the results of the magnetical observations. M. Müller's part is more particularly confined to deriving the elements of the earth's magnetism at a considerable number of stations, all in North-East Siberia, by a few observations of the declination, dip, and horizontal force at each. M. Jürgens took charge of the Ssagastyr station, where, in greater detail, he sought not only the absolute force, but the hourly variation of the magnetic elements. M. Müller, as his share, is able to present a table in which, for seventeen stations, the three elements have been fairly well determined, while in twenty-eight more or less complete observations have been made. From November 1882 to June 1884, M. Jürgens' department made hourly observations of the declination, and of the horizontal and vertical force, and on selected days observations at every five minutes. The instruments appear to have been critically examined, and the results of an inquiry conducted so far away from beaten tracks possesses a special interest.

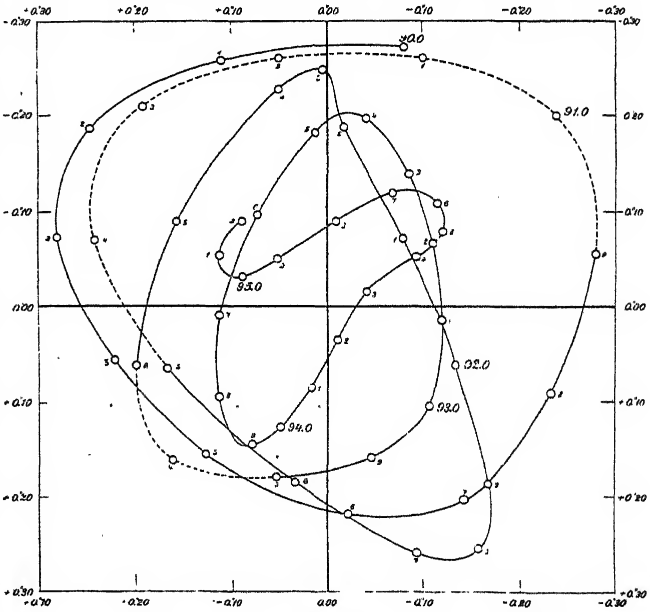
Advantage was taken of the peculiar position to make some observations on the aurora as to its form, colour, direction, and altitude. These will be found in what may be called the third section, together with the history of the expedition written by Dr. A. Bunge, wherein will be found many interesting remarks on a country but little known. The climate, the native inhabitants, the flora and fauna of the district, all come more or less under his observant notice, and are treated easily and pleasantly.

In the second work the element of adventure is, of course, wanting, and, with greater ease, Dr. Palazzo has been able to collect his data from various points on the Italian Peninsula, in such a way as to present a tolerably complete magnetic survey of the whole country. A chain of stations has been selected, starting from Rome and proceeding south-east past Naples towards Brindisi. Other positions have been occupied on the Adriatic coast, including one in the Tremiti Isles; while another group occupies the north-east, and includes Venice, Ravenna, and other well-known places. The entire series includes twenty-two stations. Dr. Palazzo has devoted great attention to the form of his instruments, and has been alive to the importance of deriving the instrumental constants with accuracy. His method of procedure is set out at length in the first part of his paper. In the second part, the details of his observations are given. On the average, these do not extend over more than two or three days at each station, which have sufficed for the determination of the declination by observing azimuths of the sun. The horizontal force has been obtained by the method of counting the number of oscillations made by the magnet in a given time. These in connection with the dip, also derived at each of the stations, have permitted him, in the usual method, to derive the vertical force and total intensity. The whole operation and deductions are conveniently exhibited in symmetrically arranged tables.

THE MOVEMENTS OF THE TERRESTRIAL POLE DURING THE YEARS 1890-95.

TOWARDS the latter end of last year Prof. Albrech gave a preliminary account of the, then, known movements of the terrestrial pole at the eleventh general conference of the "International Erdmessung." Since that date he has made a more definite investigation, the results of which will be published in the *Verhandlungen der Berliner Conferenz*; but as this will not just yet appear, he gives in the current number of the *Astr. Nach.* (No. 3333) a brief summary of the results.

The observations have been made at several observatories, namely, Kasan, Pulkowa, Prag, Berlin, Bamberg, Kiel, Karlsruhe, Strassburg, New York (Columbia College), and Bethlehem, also at the Military Geographical Institute in Vienna, the



Curve showing the relation between the *mean* and *apparent* positions of the pole during the years 1890-95.

Geodetic Institute in Potsdam, and at the American Coast and Geodetic Survey.

Prof. Albrech has not, however, used all the observations in the discussion, but enough "um den Versuch einer Ableitung der Bahn des Pols für den ganzen fünfjährigen Zeitraum mit Aussicht auf Erfolg durchführen zu konnen."

The method of computation adopted was somewhat analogous to that employed by Kostinsky in 1893. Commencing with the monthly observed mean from each station, the deviations $(\phi - \phi_0)$ of the instantaneous pole elevations from a very accurate mean value were graphically formed for every tenth part of the year; a system of coordinates was also arranged in which the positive-axis of x pointed towards Greenwich, that of y 90° to the westward, the origin coinciding with the mean position of the pole.

In this way Prof. Albrech obtained a series of points, which, when plotted out and connected together by means of a curve, would show the relation of the position of the terrestrial pole, at any moment during the interval covered by the observations, to its mean position.

The accompanying curve is a reproduction of that given by Prof. Albrech.

It will be seen that the curve commences moving round the origin of coordinates, gradually closing up, and becoming more elongated in form, the difference between its instantaneous and mean positions decreasing up to 1895 very perceptibly. The dotted path is traced through points which have been interpolated, and which could not be directly obtained owing to insufficiency of observations.

The general trend of the plotted points indicates an unmistakable decrease in the amplitude during the five years of observation, and, as Prof. Albrech points out, the movement is by no means simple, but necessitates the presence of more terms in the expression for representing this motion.

The communication concludes with a table giving the values for every 30° of longitude of the terms

$$x \cos \lambda + y \sin \lambda$$
$$\text{and } y \cos \lambda - x \sin \lambda$$

for the different epochs in connection with the three equations for calculating the variations in the altitude, azimuth, and longitude, namely,

$$\phi - \phi_0 = + x \cos \lambda + y \sin \lambda$$
$$a - a_0 = + (y \cos \lambda - x \sin \lambda) \sec \phi$$
$$\lambda \quad \lambda_0 = - (y \cos \lambda - x \sin \lambda) \tan \phi$$

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. J. J. Thomson, F.R.S., has been appointed Rede Lecturer for the present year.

The Natural Sciences Tripos will begin on May 27, and the various practical and oral examinations will not be concluded until June 16.

Prof. Ramsay, F.R.S., has been appointed an Elector to the Jacksonian Professorship of Natural Philosophy, now held by Prof. Dewar, F.R.S.

A meeting of members of the Senate, presided over by the Provost of King's, was held on Saturday last, at which resolutions were passed unanimously in favour of granting a titular recognition (such as an honorary B.A.) to qualified women, and against conceding anything that might lead to the transformation of Cambridge into a "mixed" University.

SIR HENRY ROSCOE has been elected Vice-Chancellor of the University of London, in the place of the late Sir Julian Goldsmid. Mr. F. V. Dickins, the Assistant-Registrar, has been elected Registrar, in the place of Mr. A. Milman, retired.

WE have received a combined Calendar, History, and General Summary of Regulations of the Department of Science and Art (1896). From the statistics therein given it appears that there are 2889 Science and Art Schools in the United Kingdom, and that they contain among them 167,822 students in science classes, and 132,256 students in art classes.

THE fourth annual Report of the Technical Instruction Sub-Committee of the City of Liverpool, which deals with the work accomplished by them during 1895, is eminently satisfactory. Abundant evidence is furnished that great things have been accomplished in Liverpool during the past year. Preliminary steps have been taken towards the erection of a central institution for the accommodation of evening science and technological classes. Three organised day science schools have been established; and a school of applied arts has been called into existence. An electro-technical department, evening courses of advanced work in the engineering laboratories, a special department dealing with the science and art of education, have all grown up at the University College of the city as a result of the assistance given by the Technical Instruction Sub-Committee. But the difficulty arising from insufficient previous education, which is hampering the work of similar Committees in all parts of the country, is very much felt in Liverpool. The Chairman reports: "Institutions which were founded to give a strictly technical education have had, in many cases, to enlarge their borders, and provide preparatory departments or classes, in which to prepare students, by a general preliminary training, to take proper advantage of the special technical teaching." We cordially commend the following decision of the Liverpool Committee to all whom it may concern: "Partly on this ground, but still more from a conviction that the best preparation for commercial pursuits—the staple 'industry' of Liverpool—is to be found in a thoroughly good modern general education, the Committee have sought to encourage and assist the public secondary schools of the city to adapt themselves to give such an education."

The variegated nature of the technical education which has been developed throughout the country as a result of the Acts dealing with the question, is strikingly apparent to us each time we receive a new report. Though that of Liverpool is so satisfactory as a whole, its list of "technical" subjects emphasises this point yet again. On p. 49 of the Technical Instruction Committee's report, we find they encourage the teaching (amongst a large number of other subjects) of singing and musical notation, instrumental music, type-writing, tailors' work, cabinet-making, ship carpentry and joinery, and so on. The extraordinary thing is, in view of the express clause of the Technical Instruction Act, 1889, "that technical instruction shall not include teaching the practice of any trade or industry, or employment," that the Science and Art Department should sanction such subjects as these.

SCIENTIFIC SERIALS.

Bulletin de la Société des Naturalistes de Moscou, 1895, No. 1.—The vascular cryptogams of the Middle Urals and the surrounding territory, by P. W. Ssüsew (in German). The ferns which freely grow in the shadow of the pine forests of the Urals, make a substantial and most picturesque part of the flora of the country. The most common species are:—*Polypodium dryopteris*, *Phegopteris polypodiodides*, *Athyrium filix femina*, *Asplenium crenatum*, *Aspidium spinulosum*, &c. In the stony parts of the highlands one finds the elegant species of *Allosurus*, *Woodsia*, *Asplenium ruta muraria*, *A. viride*, *A. septentrionale*, and many others, which disappear already at a short distance from the Ural range, although the conditions for their growth seem to be the same. Latest research has shown that only three species, characteristic of the Northern Urals, do not appear in the middle and southern parts of these mountains. Forty-seven different species are described.—On adhesion between metals, glass, and different other substances, by J. Weinberg (German). The observations of M. Charles Margot are discussed, and the author shows that the different degrees of adhesion between different substances agree with his molecular formula.—From the shores of the Mediterranean, by H. Trautschold (in German). The structure of the conglomerates and other deposits on the shores of the Mediterranean Sea at Nizza is discussed in order to show that the phenomena are best explained by a retreat of the sea, but do not agree with an upheaval of the coast.—*Lanius eleagni*, a new species, akin to *Otomela Bogdanowii*, Bianchi, by P. Suschkin.—The tail-organ of the *Raja*, by N. Iwanzoff (in German), with three plates. Detailed anatomical work, in which the difficulties that the pseudo-electrical organs of fishes are supposed to offer to Darwin's theory are discussed and explained.—On the *Libellulideæ* of Poltava and Kharkov, by V. N. Roozianko (in Russian). Fourteen species are described.—Catalogue of the fungi of Smolensk, by A. A. Jaczewski (in Russian). Two hundred and fifty-four species are enumerated. The author makes the remark that the forests are extremely rich in species of *Russula*, and that all the species of this genus, without exception, are used for food by the peasants, but that cases of poisoning are never heard of. He makes the suggestion that perhaps the poisonous species, *Russula emetica* and *R. rubra*, are very rare (each was found only once); but altogether it must be supposed that the manner of cooking destroys their poisonous properties, if they exist—a question which well deserves scientific investigation.—List of members.

Bollettino della Società Sismologica Italiana, vol. i., 1896, No. 8.—The Cecchi microseismograph, by G. Giovannozzi. The first description of the instrument published in a scientific journal.—Hydrothermal observations at Fiumecaldo (Catania) in May and June 1895, by C. Guzzanti.—Notices of Italian earthquakes (June–July 1895), the more important being the Venetian and Lubiano earthquakes of June 10, and the disastrous earthquake which occurred on the east coast of the Caspian Sea during the night of July 8–9. Copies of two of the microseismographic records of the latter earthquake obtained at Rome are given.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1895.—"Impact with a Liquid Surface, studied by means of Instantaneous Photography." By Prof. A. M. Worthington, F.R.S., and Mr. R. S. Cole.

This communication was the first instalment of a review by the aid of instantaneous photography of the ground covered by three previous papers (*Roy. Soc. Proc.*, vol. xxv. pp. 261 and 498, 1877, and *ibid.*, vol. xxxiv. p. 217, 1882), in which the phenomena that accompany various kinds of splashes are described. The advance made lies in the unquestionable accuracy and fullness of detail of the information now afforded.

Chemical Society, February 6.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—The molecular weight and formula of phosphoric anhydride and of metaphosphoric acid, by W. A. Tilden and R. E. Barnet. Vapour density determinations of phosphoric anhydride show that it has the molecular composition P_4O_{10}; metaphosphoric acid, which partially dissociates into water and the anhydride on heating, is similarly shown to have the formula $H_2P_2O_6$.—Lead tetracetate and the plumbic salts, by A. Hutchinson and W. Pollard. Lead tetracetate, prepared by dissolving red lead in acetic acid, crystallises in monosymmetric needles. Lead tetraphosphate and tetrapropionate have also been prepared.—An improved method of determining urea by the hypobromite process, by A. H. Allen. The incomplete evolution of nitrogen occurring when hypobromite is added to urea may be avoided by mixing potassium cyanate with the urea solution; it is also preferable to run the urea and cyanate solution into the hypobromite instead of *vice versâ*.—Preliminary note on the absorption of moisture by deliquescent salts, by H. W. Hake. The author has determined the amount of water absorbed by exposing deliquescent salts to the air, and finds that in many cases the amount of water taken up points to the formation of a definite hydrate.—Some derivatives of γ-phenoxyethylmalonic acid and of γ-phenoxyethylacetic acid, by W. H. Bentley, E. Haworth, and W. H. Perkin, jun.—Note on the preparation of glycol, by E. Haworth and W. H. Perkin, jun.—Luteolin, by A. G. Perkin. Luteolin, the yellow colouring matter of Weld (*Reseda luteola*), has the composition $C_{15}H_{10}O_6$, combines with mineral acids, and yields tetracidic derivatives; it seems to be allied to its isomeride fisetin.—An examination of the products obtained by the dry distillation of bran with lime, by W. F. Laycock. On distilling bran with quicklime an aqueous and oily distillate is obtained, which contains ammonia, ketones, ethylic alcohol, pyridines, pyrrolines, furfuranes, hydrocarbons, and an indole.—Constitution of glycocine, by Jōji Sakurai.

Entomological Society, February 5.—Prof. Raphael Meldola, F.R.S., President, in the chair.—The President announced that he had nominated Dr. D. Sharp, F.R.S., Mr. Roland Trimen, F.R.S., and Mr. Walter F. H. Blandford, Vice-Presidents for the Session 1896-97.—Mr. Waterhouse exhibited pupæ and portions of pupæ of a silk moth, *Antheræa mylitta*, selected from some scores of specimens, which he had opened to see if they showed stages of development agreeing with the examples given by Dr. Spuler. The results appeared to confirm Dr. Spuler's researches: some specimens showed the tracheæ, the median vein having two branches, very rarely emitting a third branch in the direction of the radial. Other specimens had faint indications of the veins and of the discoidal spot of the imago. Even at this very early stage the vein branching from the subcostal vein to unite with the upper radial, and the short branch uniting the second median vein with the third median were distinctly traceable, no tracheæ being yet visible in these branches. Mr. Merrifield, Mr. Hampson, and Dr. Sharp took part in the discussion which ensued.—Mr. E. E. Green remarked that in the *Trans. Ent. Soc.*, 1881, p. 601, there was a short paper by the late Prof. J. O. Westwood, describing a curious little insect from Ceylon under the name of *Dyscritina longisetosa*. Prof. Westwood believed his typical specimens to be immature. Mr. Green exhibited what he supposed to be a later stage of the same species. He said his example differed in some particulars from Westwood's description and figure—notably in the proportions of the caudal appendages. Prof. Westwood pointed out the affinities of *Dyscritina* to the Forficulidæ. This was very apparent in the specimen under consideration. Putting aside the nature of the caudal appendages the insect was in all particulars an earwig. The present specimen was taken in the Punduloya district of Ceylon, at an elevation of about 4000 feet. Mr. Green said he had more than once seen this insect under loose pieces of bark and in crevices of rocks, and had always been struck by its likeness to an earwig both in appearance and habits. Mr. McLachlan, F.R.S., Dr. Sharp, Mr. Gahan, Mr. Blandford, and Mr. Hampson made some remarks on the subject.—Mr. O. E. Janson exhibited a Goliath beetle, from the Upper Congo, which he believed to be the male of *Goliathus rusus*, Kolbe, described from a unique female example in the Berlin Museum.—Mr. Blandford called attention to the case of the eye of a boy affected with inflammation caused by the hairs of the larvæ of *Lasiocampa rubi*. The attack recurred after an interval of nineteen weeks, and in several continental cases this recurrence of the attack had been found to take place, and in some cases permanent injury to the eye had followed. Mr. Blandford discussed the various kinds of hairs on several caterpillars, certain species having hairs of two kinds, one kind being barbed, and thus having the power to work into the skin. He said that the urticating property of the hairs appeared to be mechanical: there was no evidence of any poison glands. Mr. Lawford said he had had some difficulty in discovering hairs in the lid, and he thought that the symptoms in the case in question were not to be explained by mechanical irritation due to the presence of hairs in the tissues. The subject was a new one to him, and he had looked up all the medical literature bearing on it. Lord Walsingham, F.R.S., Mr. Tutt, Prof. Poulton, F.R.S., Canon Fowler, and Mr. Jacoby made some remarks on the subject.—Dr. F. A. Dixey read a paper entitled "On the Relation of Mimetic Patterns to the Original Form." The paper was illustrated by a number of coloured diagrams. Prof. Poulton expressed his gratification with the paper, and that the Hope Collection under his charge had afforded material for the work. He thought the result of the paper was to give support to the theories of Fritz Müller rather than to those of Bates. Mr. Blandford, Mr. Tutt, and Prof. Meldola continued the discussion.—Dr. Sharp contributed a paper entitled "The Rhynchophorous Coleoptera of Japan. Part iv."

Linnean Society, February 6.—Mr. C. B. Clarke, F.R.S., President, in the chair.—Sir W. H. Flower, K.C.B., F.R.S., presented to the Society, on behalf of the subscribers, a portrait of Mr. William Carruthers, F.R.S., a former President of the Linnean Society, painted by Mr. J. Hay. At the motion of Mr. J. G. Baker, F.R.S., it was resolved that the portrait be accepted, and that a cordial vote of thanks to the donors be recorded.—Prof. C. Stewart exhibited a series of dissections of skulls, illustrating the development of air cavities. The skull of a herring, carefully dissected to show the relations of the ampullæ of the pneumatocyst to the cranial bones; of a crocodile, to show those of the extra tympanic cavity and siphonium; of a rook, to show the limitations and relationships of the vesicular and other strata of the cranial roof; and of a chinchilla and a *Phascolarctus*, to illustrate the variations and development of the "bulla" and of its associated structures, were the chief objects shown. Prof. Stewart expressed himself favourable to the belief that the parts mentioned in the herring are functional for acoustic purposes. In this he was supported by Prof. Howes, who referred in detail to the arrangements occurring in *Hyodon* and *Myonomyrus* as substantiating this conclusion.—On behalf of Mr. B. G. Cormack, Dr. D. H. Scott gave the substance of a paper on polystelic roots of certain palms. He remarked that with scarcely any exception roots show one normal vascular bundle or stele. The author, utilising material from Ceylon, found that in *Areca Catechu*, Linn., *Cocos nucifera*, Linn., and a species of *Verschaffeltia*, the young roots agree with this condition, but on examining older and thicker portions of the same roots, he found many steles present. After discussing the origin of this, the author considered the change to be primary, not secondary, and suggested that these roots might serve as props to the stem. The paper was criticised by Mr. George Murray and Prof. Trail, Dr. Scott replying to objections. Mr. R. Morton Middleton then read a paper on a remarkable use of ants in Asia Minor, communicated by Mr. Miltiades Issigonis, of Smyrna. It was stated that the Greek barber-surgeons of the Levant employed a large species of ant for the purpose of holding together the edges of an incised wound. The ant, held with a forceps, opens its mandibles wide, and being then permitted to seize the edges of the cut, which are held together for the purpose, as soon as a firm grip is obtained the head is severed from the body. Mr. Issigonis had seen natives with wounds in

course of healing, with the assistance of seven or eight ants' heads. The species of ant referred to was a large-headed *Camponotus*, not unlike one found in India. Mr. Middleton recalled the fact that a similar observation, concerning a species of ant in Brazil, had been recorded many years ago by Mr. Mocquerys, of Rouen (*Ann. Soc. Entom. France*, 2[me] sér. ii. 67), as quoted by Sir John Lubbock in his work on ants, bees, and wasps; but the observation, strange to say, had not been confirmed either by Bates or Wallace during their travels in South America. Dr. John Lowe pointed out that in this operation apparently no attention was paid to the usual antiseptic precautions which are regarded as indispensable in modern surgery. Sir William Flower considered the observation of much interest from an ethnological point of view, as showing the independent existence of the same custom in countries so far apart as Brazil and Asia Minor.

Mathematical Society, February 13.—Prof. M. J. M. Hill, F.R.S., Vice-President, in the chair.—The Chairman read the opening paragraphs of a paper by Prof. Forsyth, F.R.S., entitled "Geodesics on a Quadric, not of Revolution."—Prof. Elliott, F.R.S., gave an account of a paper by Mr. A. L. Dixon, on the potential of cyclides.—Mr. Love, F.R S. (Hon. Sec.), communicated a paper on solid ellipsoidal vortex, by Mr. R. Hargreaves.—Dr. J. Larmor, F.R.S., and Lieut.-Colonel Cunningham took part in the discussions on the papers.—The Chairman (Mr. M. Jenkins, Vice-President *pro tem.*, in the chair) and Mr. Tucker (Hon. Sec.) made short impromptu communications. The latter was to the effect that if any square PQRS be inscribed in a circle ABC, and the Wallace lines of P, Q, R, S, with regard to the triangle ABC be drawn, they form by their intersection a quadrilateral the mid-points of whose *three* diagonals are the centre and ends of a diameter of the nine-point circle of ABC.

Zoological Society, February 18.—Prof. G. B. Howes in the chair.—A communication was read from Dr. Arthur G. Butler on the butterflies obtained in Arabia and Somaliland by Captain Charles G. Nurse and Colonel J. W. Yerbury in 1894-95.—A communication was read from Lord Walsingham, F.R.S., and Mr. G. F. Hampson, on the moths collected at Aden and Somaliland by the same naturalists and by other collectors.—Mr. F. E. Beddard, F.R.S., communicated (on behalf of Miss Marion Newbigin) a paper dealing with the metallic colours of humming-birds and sun-birds. It had been held that these peculiarly coloured feathers played some special part in the economy of the bird, for they could not be of much use for flight owing to the disconnected barbules. The author combated this view, pointing out in the first place that the statement of fact did not apply to all humming-birds, in the metallic feathers of which the barbules were often connected by cilia. It was urged in the next place that the very perfection of the flight of humming-birds led to correlated variations in feather structure productive of their especially brilliant metallic tints. The difficulty of the plain-coloured swifts—possibly near allies of the humming-birds—was met by the suggestion that the latter have fewer enemies, and had therefore had greater scope of possible colour-variation.—Mr. C. W. Andrews read a note on a skull of *Orycteropus gaudryi*, an extinct species of ant-bear from the Lower Pliocene deposits of Samos, originally discovered and described by Dr. C. J. Forsyth-Major.—Mr. Frank E. Beddard, F.R.S., read a paper upon the anatomy of the Scissor-bill (*Rhynchops*), in which the structure of the viscera and muscles of this bird were described. The muscular anatomy was found to differ greatly from that of the gulls, skuas, and terns, and was held amply to justify its separation as a distinct subfamily *Rhynchopinæ*.

PARIS.

Academy of Sciences, February 17.—M. Cornu in the chair.—Preparation and properties of cerium carbide, by M H. Moissan. This substance, of which the composition is CeC_2, is produced in the electric furnace from charcoal and CeO_2. Its properties and reactions are similar to those of other carbides previously described, water, however, giving a gas containing ethylene (4 per cent.), methane (21 per cent.), and acetylene (75 per cent.), the composition of the gas obtained in different experiments being very constant. A small proportion of the carbon is obtained in the form of liquid and solid hydrocarbons.—On carbide of lithium, by the same. This carbide, LiC_2, forms a transparent crystalline mass, which, on account of its high percentage of carbon (69 per cent.), acts as a powerful reducing agent. It is volatile at the temperature of the electric furnace, with partial decomposition into its elements, and on treatment with water yields pure acetylene.—Observations of the Perrine comets (*a* 1896 and *c* 1895) made at the Observatory of Paris, by M. G. Bigourdan.—Observations on the Perrine comet made with the large equatorial at the Observatory of Bordeaux, by M. L. Picart.—On the integration of some partial differential equations, by M. Le Roy.—On Taylor's theorem, with approximation to the third degree, by M. N. Bougaief.—On groups of substitutions, by M. A. Miller.—On sensitive flames, by M. E. Bouty. A study of the influence of the nature of the gas on the sensibility to sound. The sensitiveness of a pure hydrogen flame is very small, but it can be increased by the addition of a sufficient proportion of an inert gas, such as nitrogen or carbon dioxide. Pure acetylene gives only a moderately sensitive flame, but a mixture of equal volumes of hydrogen and acetylene responds readily to the ticking of a watch.—On the lowering of the statical and dynamical explosive potentials by the X-rays, by M. R. Swyngedauw.—Electric phenomena produced by the Röntgen rays, by M. A. Righi.—Action of the Röntgen rays on the electrostatic charges and the explosive distance, by MM. J. J. Borgman and A. L. Gerchun.—New researches on the X-rays, by MM. Benoist and D. Hurmuzescu.—Photographic researches on the Röntgen rays, by MM. Auguste and Louis Lumière.—An experiment showing that the X-rays proceed from the anode, by M. de Heen.—Photographs obtained with the Röntgen rays, by MM. A. Imbert and H. Bertin-Sans.—On the property possessed by phosphorescent rays of passing through bodies opaque to solar light, by M. G. H. Niewenglowski.—Nature and properties of dark light, by M. Gustave Le Bon.—Photographic prints obtained in the dark, by M. A. Briançon.—On a rapid method for the estimation of arsenic, by MM. R. Engel and J. Bernard. The arsenic is precipitated in hydrochloric acid solution by hypophosphorous acid, and titrated with standard iodine solution in presence of sodium bicarbonate. The results of the test analyses are satisfactory.—Partial synthesis of geranic acid and constitution of lemonol and lemonal, by MM. P. Barbier and L. Bouveault.—On some derivatives of eugenol, by M. Ch. Gassman.—On the composition of fire-damp, by M. T. Schlœsing, jun. A careful examination of the combustible gas in sixteen samples of fire-damp, from various mines, showed that in thirteen cases the hydrocarbon was pure methane; in the other three, besides methane, traces of ethane (from 2–4 per cent.) appeared to be present.—Walking and running *en flexion*, by MM. Comte and Regnault. A study of a new method of walking and running called *en flexion*, on account of a sudden bend of the knee at a particular point of the stride. It is shown that in this method, which has already been proved to be of great practical advantage in the movement of troops, the vertical oscillations of the body are rendered more gradual, besides being reduced in magnitude. A dynamographic study of the variations of the pressure on the feet also brings out the same point, sudden variations of pressure disappearing from the curve—On a new application of photography, by M. G. Guéroult.—Some applications of a mode of production of colour, hitherto unexplained, by M. C. Henry.—Undulatory irradiation of luminous impression, by M. A. Charpentier.—Assimilation and activity, by M. P. Vuillemin.—On an epidemic of pneumonia of the hare, caused by *Strongylus retortæformis*, Zeder, by M. E. Yung.—The lacunar apparatus of the starfish, by M. L. Cuénot.

BERLIN.

Physiological Society, January 10.—Prof. Munk, President, in the chair.—Dr. Joachimsthal spoke on a supposed self-regulative process in muscles as based on the observation that the calf-muscles are long and thin in negroes, but short and thick in whites. This depends on the relative lengths of the calcaneum. In the negro the muscle is inserted on a longer arm of this bone, and this necessitates a more extended contraction of the muscle; in a white man the arm is shorter, but this requires a correspondingly greater force, and hence the muscle is shorter and thicker. An experiment had been made by Marey on rabbits with reference to the above, and the speaker described some recently made by himself on a cat in support of his views. In the subsequent discussion considerable objection was raised against the validity of the experiments, some of the results being attributed to muscular atrophy.—Prof. Zuntz reported on experiments made by Dr. Lewin, of New York, in which, using a dog, the stomach had been connected directly with the intestine so as

to exclude that portion into which the ducts of the liver and pancreas open. He then fed the animal on cream, and found that in no single case was any of the emulsified fat absorbed.—Dr. R. du Bois Reymond exhibited a number of Röntgen photographs.

January 24.—Prof. du Bois Reymond, President, in the chair.—Dr. Apolant spoke on the ciliary ganglion, which has at one time been regarded as a spinal, at another time as a sympathetic structure, these views being based on anatomical, morphological, embryological and physiological researches. Of late years it has been shown by stimulation that this ganglion is in the closest relationship to the oculomotor nerve, and the speaker had made experiments on cats and found that the degeneration set up by section of this nerve progresses only as far as the cells of the ganglion; whereas the latter, as well as the ciliary nerves which spring from them, remain intact. He hence concluded that the ganglion belongs to the sympathetic system.—Dr. Rawitz described how he had, by means of his new method of staining, investigated the attraction-spheres in the testicular cells of salamander maculosa during the first stages of division. He found that the sphere, which is stained dark by alizarin, becomes larger and stains less deeply, after which amœboid processes make their appearance on its surface. These then separate off in a globular form, whereby the sphere becomes divided up into some six or nine small dark spherules. Later on the central zone of the sphere becomes elongated, oval, and spindle-shaped, the spherules arranging themselves longitudinally in the axis of the spindle. After this the central spherules disappear, leaving only the two polar end particles, which then undergo the ordinary well-known later changes. These observations were made on salamanders caught in June; later in the year, the above phases were no longer to be seen.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, FEBRUARY 27.

ROYAL SOCIETY, at 4.30.—On the Spinal-Root Connections and Ganglion-cell Connections of the Nerve Fibres which produce Contraction of the Spleen: Prof. Schäfer, F.R.S., and B. Moore.—A Method for rapidly producing Diphtheria Antitoxines. Preliminary Note: Dr. C. Wood.
ROYAL INSTITUTION, at 3.—Some Aspects of Modern Botany: Prof. H. Marshall Ward, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electric Wiring Question: F. Bathurst.—Concentric Wiring: Sam. Mavor.—High-Voltage Lamps and their Influence on Central Station Practice: G. L. Addenbrooke.
SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 9.—Marine Organisms and their Conditions of Environment: Dr. John Murray.
PHYSICAL SOCIETY, at 5.—Experiments with Incandescent Lamps: Sir D. Salomons.—The Alternating Current Arc: Messrs. Fleming and Petavel.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Loughborough Sewage-Disposal Works: Arthur S. Butterworth.

SATURDAY, FEBRUARY 29.

ROYAL INSTITUTION, at 3.—Light: Lord Rayleigh, F.R.S.

MONDAY, MARCH 2.

SOCIETY OF ARTS, at 8.—The Chemistry of certain Metals and their Compounds used in Building, and the Changes produced in them by Air, Moisture, and Noxious Gases, &c.: Prof. J. M. Thomson.
SOCIETY OF CHEMICAL INDUSTRY (Burlington House), at 8.—Artificial Silk: Messrs. Cross and Bevan.
VICTORIA INSTITUTE, at 4.30.—Paper by Dr. Guppy.

TUESDAY, MARCH 3.

ROYAL INSTITUTION, at 3.—The External Covering of Plants and Animals: Prof. Charles Stewart.
SOCIETY OF ARTS, at 8.—The Commercial Prospects of English East Africa and British Central Africa: G. Scott Elliot.
ZOOLOGICAL SOCIETY, at 8.—Remarks on the Divergences between the "Rules for Naming Animals" of the German Zoological Society and the Stricklandian Code of Nomenclature (to introduce a discussion on Zoological Nomenclature): P. L. Sclater, F.R.S.—On the Ornithological Researches of M. Jean Kalinowski in Central Peru: Graf Hans v. Berlepsch and J. Stolzmann.—On West Indian Terrestrial Isopod Crustaceans: Adrian Dollfus.
INSTITUTION OF CIVIL ENGINEERS, at 8.—On Littoral Drift in relation to River-Outfalls and to Harbour-Entrances: William Henry Wheeler.
PATHOLOGICAL SOCIETY, at 8.30.
ROYAL VICTORIA HALL, at 8.30.—A Visit to the Orkney Islands: J. Saxon Mills.

WEDNESDAY, MARCH 4.

SOCIETY OF ARTS, at 8.—Röntgen's Photography of the Invisible: A. A. Campbell Swinton.
BRITISH ARCHÆOLOGICAL ASSOCIATION, at 8.
ENTOMOLOGICAL SOCIETY, at 8.
SOCIETY OF PUBLIC ANALYSTS, at 8.—On the Estimation of the Diastatic Power of Malt: Dr. Walter J. Sykes and C. A. Mitchell.—Further Note on the Detection of Formalin: H. Droop Richmond and L. K. Boseley.—The Detection of Formalin: Otto Hehner.—Note on the Detection of Cotton-Seed Oil in Lard: E. J. Bevan.

THURSDAY, MARCH 5.

ROYAL SOCIETY, at 4.30.
ROYAL INSTITUTION, at 3.—Masters of Modern Thought. I. Voltaire: Rev. William Barry.
LINNEAN SOCIETY, at 8.—Segmentally-disposed Thoracic Glands in the Larvæ of Trichoptera: Prof. Gustav Gilson.
CHEMICAL SOCIETY, at 8.—On the Explosion of Cyanogen: H. B. Dixon, E. H. Strange, and E. Graham.—On the Mode of Burning of Carbon: H. B. Dixon.—On the Detonation of Chlorine Peroxide: H. B. Dixon and J. A. Harker.—The Constitution of a New Acid resulting from the Oxidation of Tartaric Acid: H. J. H. Fenton.
SOCIETY OF ANTIQUARIES, at 8.30.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Results of Rain, River, and Evaporation Observations made in New South Wales, 1894. H. C. Russell (Sydney).—Studien zu Methodenlehre und Erkenntnisskritik: F. Dreyer (Leipzig, Engelmann).—The Present Evolution of Man: G. A. Reid (Chapman).—Applied Magnetism: J. A. Kingdon (Alabaster).—By Tangled Paths: H. M. Briggs (Warne).—The Primary Factors of Organic Evolution: Prof. E. D. Cope (Open Court Publishing Company).—Calendar, History, and General Summary of Regulations of the Department of Science and Art, 1896 (Eyre).—British Moths: J. W. Tutt (Routledge).—Résultats de l'Examen de Dix Mille Observations de Hernies: Prof. P. Berger (Paris, Alcan).—The Methods of Microscopical Research: A. C. Cole, 2nd edition (Baillière).—Lehrbuch der Experimental Physik: Prof. E. Riecke (Leipzig, Veit).—Géométrie Descriptive: A. Gouilly (Paris, Gauthier-Villars).—Calendario del Santuario di Pompei, 1896 (Valle di Pompei).—Exercises in Physical Measurement: Drs Austin and Thwing (Boston, Allyn).—Leçons sur l'Électricité et Le Magnétisme de E. Mascart et J. Joubert, deux édition. E. Mascart, tome premier (Paris, Masson).

PAMPHLETS.—The Ballarat Field (Robertson).—Geological Literature added to the Geological Society's Library during the Year ended December 31, 1895 (Geological Society).—Report of Observations of Injurious Insects, &c., 19th Report: E. A. Ormerod (Simpkin).—Realgymnasium des Johanneums zu Hamburg (Hamburg).

SERIALS.—Royal Natural History, Vol. v. Part 28 (Warne).—Beiträge zur Psychologie und Philosophie, i. Band, i. Heft (Leipzig, Engelmann).—Quarterly Journal of the Geological Society, No. 205 (Longmans).—The Aeronautical Annual, No. 2 (Wesley).—Princeton Contributions to Psychology, January (Princeton).—Psychological Review Index for 1895 (Macmillan).—National Geographic Magazine, February (Marlborough).—Bulletin de l'Académie Royale des Sciences, &c, de Belgique, 1896, No. 1 (Bruxelles).

CONTENTS.

THURSDAY, MARCH 5, 1896.

THEORIES OF EVOLUTION.

Darwin and After Darwin: an Exposition of the Darwinian Theory, and a Discussion of Post-Darwinian Questions. By the late G. J. Romanes, F.R.S. &c. II. Post-Darwinian Questions—Heredity and Utility. Pp. 344. (London: Longmans, Green, and Co., 1895.)

PROF. LLOYD MORGAN tells us, in a prefatory note, that the greater part of this work was in type before the lamented death of the author. The material for chapters v. and vi. existed in the form of "notes and isolated paragraphs," which have been arranged for the press, but otherwise practically untouched. The editor has performed his task with great skill, and has succeeded in attaining the object which he wisely held in view—the production of a work which is in every way characteristic of its author and of no one else.

The frontispiece is an admirable reproduction of a photograph of the author—a most excellent likeness, which will, in itself, invest the book with deep interest for many readers.

Of the ten chapters, the first is introductory, the succeeding five deal with "characters as hereditary and acquired," while the remaining four are devoted to "characters as adaptive and specific."

In the introductory chapter, the views of Darwin and Wallace are contrasted in much detail. In a table on p. 6, "the theory of Natural Selection according to Darwin" is apparently compared with "the theory of Natural Selection according to Wallace": in reality, however, the theories are not compared or contrasted in any way—the only comparison being in the extent to which they were applied by these two naturalists respectively, and in their use or neglect of accessory theories. The high importance which Wallace ascribes to natural selection, and his inability to accept any other existing suggestions as to the origin of species, are, in this table, brought together into a set of dogmatic statements, which, as the present writer thinks, are far from expressing his views.

It is contended that Darwin progressively ascribed less and less importance to natural selection: "The longer he lived, and the more he pondered these points, the less exclusive was the *rôle* which he assigned to natural selection, and the more importance did he attribute to the supplementary factors" (p. 8; see also p. 40). Some of his latest letters, however, do not support this view of an unbroken progressive tendency.

Many of the author's well-known arguments against the use of the term "Darwinism," as opposed to "Lamarckism," are here reproduced and brought forward in a very forcible manner. The contest, however, is entirely due to the fact that the combatants ascribe different meanings to the same word. To the author, "Darwinism" means the whole of the views which Darwin entertained upon the origin of species; to his opponents, "Darwinism" means those views upon this subject which were originated by Darwin (viz. the theory of natural selection). It is no doubt true, as is contended on pp. 10, 11, that the "Lamarckian" principles (of use and disuse, &c.) accepted by Darwin were independently conceived by him, and that he did not owe them to Lamarck; but the fact remains that they were originated by the latter, and not by Darwin.

The latter part of the introductory chapter deals in a brief but very effective manner with the three theories of evolution associated with the names of Cope, Geddes, and Henslow, and in greater detail with Wallace's well-known views upon the insufficiency of natural selection to account for the origin of the human race.

In chapter ii. the relationship between Weismann's views is represented in the diagram on p. 43, and in statements which describe the formation of a "postulate as to the absolute non-inheritance of acquired characters" in order to support the "deduction as to the absolute continuity of germ-plasm," and this again in order to support the further deductions "as to the theory of organic evolution" and "as to the architecture of germ-plasm." From this mode of representation the reader unacquainted with Weismann's writings, at first hand, might readily receive the impression of a flimsy speculative structure unsupported by investigation, which would be doing scant justice to the distinguished German biologist.

Weismann's theory of heredity, based on the continuity of the germ-plasm, grew directly out of his researches upon the sexual cells of Hydrozoa, and was thus founded directly upon the results of investigation. The hereditary transmission of acquired characters was not at first called into question, but, later on, the extreme difficulty of explaining such transmission by means of a theory of heredity, which on other grounds appeared to be sound, suggested an inquiry into the supposed fact of the transmission itself. This subject was then dealt with on its own merits, and it was soon apparent that the evidence had a very different bearing from that which had been generally assumed. The later and frequently changing hypotheses as to the architecture of the germ-plasm were an attempt to explain the results of the unceasing inquiry into the changes undergone by the sexual cells. Newer and more complex phases of change were ever being made out in this most fruitful field of investigation, suggesting modifications in the details of Weismann's hypothesis of the structure of germ-plasm, and not ending here, but suggesting also fresh lines of observation and research. Indeed it may be maintained that the errors which have appeared from time to time in the details of Weismann's hypotheses are due to an attempt to render the hypotheses too much up-to-date, by taking into account all the most recent observations in an exceptionally difficult line of research—observations many of which could not be final, and some of which were bound to be altogether erroneous.

It will be impossible to attempt any adequate discussion of the admirable treatment of the facts and arguments for and against the hereditary transmission of acquired characters. These chapters will require the careful consideration of writers on either side of the controversy. Not only is the discussion itself most valuable, but new facts are submitted. Brown-Séquard's experiments on guinea-pigs have been repeated with great care, but no definite conclusions can be safely drawn from the results. "On the whole, then, as regards

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Brown-Séquard's experiments, it will be seen that I have not been able to furnish any approach to a full corroboration. But I must repeat that my own experiments have not as yet been sufficiently numerous to justify me in repudiating those of his statements which I have not been ably to verify" (p. 122).

The second section of the work deals with "Utility," and opens with the contention already familiar in the author's earlier writings, that natural selection is not a theory of the origin of species, but of the origin of adaptations. The discussion throughout this section is of great interest, although perhaps somewhat too controversial in tone; but this is a consequence of previous controversies on the same subject. The effect of controversy here, as in other cases, is to emphasise the differences of opinion. The present writer ventures to think that if this question of the utility of specific characters were treated less controversially and more by the discussion of particular examples, very little difference of opinion would be found to exist. The essence of the question is contained in the definition of the term "specific character," and this again depends on the definition of the term "species." But we know that no satisfactory, viz. generally applicable, objective definition of species can be given, inasmuch as the subjective ideas of the species describer have been of pre-eminent importance.

In certain classes of cases the species describer has, and obviously correctly, made adaptive characters his criteria; for instance, in the species of Ranunculus alluded to by Mr. Thiselton-Dyer in his discussion of this question, as President of Section D, at Bath (British Association Reports, p. 692). Of the opposite kind are the various representative races or species which we meet as we trace the distribution of numerous forms of life over the earth's surface, and which are especially well seen in the Heliconine Danainæ from tropical America, in the Godman-Salvin Collection. Following one of these forms in its range we find, in numerous cases, that different areas are characterised by differences in the colours and markings of the wings. The colours and markings themselves are believed by many to be adaptive, and to be of value for the purposes of warning; but the local differences alluded to cannot be explained in this way, except in the cases of mimicry between local forms. Assuming the received explanation to be correct, natural selection would appear to have operated only in preventing the local differences from diminishing the efficiency of the warning character. But these local forms of colouring and marking are made the criteria—and are, indeed, apparently the only criteria—of specific distinction in numberless cases. It may be that, in many of these cases, future investigation will prove a biological continuity of the forms over the whole of the range, so that the names which are now applied to species will have to be used for geographical races. In the interests of biological science it is necessary that the naming of different forms should proceed at a much faster rate than the scientific proof of specific rank: indeed, the latter must, in the majority of cases, be a very slow and arduous process. Much confusion and controversy would be avoided if describers were clearly to state, as regards a large proportion of the forms described every day, that specific rank is only provisionally claimed. There is abundant justification for conferring a name, or a number, or some kind of ticket, upon every clearly marked form, quite apart from the question of its specific rank.

It therefore follows that this controversy must be a barren one as regards a very large proportion of the forms which are now distinguished as species, especially in groups like the Insecta, in which such forms are most numerous. Among the cases in which specific rank is indisputable, it can hardly be maintained that all the superficial differences between two allied species which have resulted from separation on the opposite sides of some geographical barrier, are necessarily adaptive.

This work, like all the writings of its author, is sure to appeal to a wide circle of readers, and will be of high value in bringing before the public the discussion, by an exceptionally acute thinker, of some of the most disputed and difficult points in modern theories of evolution; while biological science cannot fail to gain by the attention directed to the need for further observation and experiment in order that a final decision may be reached.

E. B. P.

COMPLETION OF THE "INDEX-CATALOGUE."

Index-Catalogue of the Library of the Surgeon-General's Office, United States Army. Authors and Subjects. Vol. xvi. W—Zythus. Folio, pp. xiv. + [282] + 822. (Washington: Government Printing Office, 1895.)

THIS sixteenth volume completes the twenty years' labour of Dr. J. S. Billings, and brings the catalogue of the finest medical library in the world to the close of the alphabet. We have in previous articles remarked on its extraordinary fulness, and its value to all engaged in the study of medical literature. For it is not merely a guide to the Washington Library; it is a classified index to something like a moiety of all that has ever been published on medicine and its allied sciences. Ample and distinctive descriptions are given of more than 300,000 books and articles, with over 800,000 cross-references. The volume before us has an additional feature of the greatest usefulness. No less than 282 folio pages are required to contain a list of the abbreviated and the complete titles of the periodicals, transactions, reports, and the like, now or formerly issued in all parts of the world and in every civilised language. The abbreviations are those used in the catalogue; but they are so concise, and at the same time so sufficient, that it would be well if they could be uniformly adopted by all who quote—and give their authority.

The recent international testimonial to Dr. Billings, and the public banquet at which, with his fellow-workers, Dr. Chadwick, of Boston, and Dr. Fletcher, originally of Bristol, he was a few weeks ago honoured in Philadelphia, have furnished some indication of the widespread feeling of grateful admiration his great enterprise has evoked among his medical and scientific brethren. The feeling has found stately expression in the Latin diploma whereby an honorary doctorate was conferred by the University of Munich on the Surgeon-General:

"A man who deserves of his country and of literature the highest praise, not only for his numerous important writings on the relations of physicians, on the proper construction and administration of hospitals, on the public health of the United States according to the precepts of the science and art of hygiene, on the preservation and improvement of the health of the army, but also for the great collections thereto relating which he has established and extended; a man who, in the "Index Medicus" of which he is the editor, includes by indefatigable industry all the branches of medicine that are being advanced throughout the whole world, who also, as author of the book entitled the "Index-Catalogue," which by the remarkable munificence of the Government of the United States has been laid before an immense number of learned men, has entitled himself to the gratitude of physicians and students of history over the entire world, and has fashioned for himself a monument more enduring than brass."

It must be remembered that not only the "Catalogue" but the Library itself is essentially of Dr. Billings' creation, and that about one-sixth of its contents have been presented either by way of direct gift or in exchange. It speaks highly for his personal "magnetism" that he can write: "There are few medical writers now living who have not sent to the Library at least one pamphlet." Thus, while the "Catalogue" has been passing through the press, a multitude of fresh gifts and additions have accumulated, and the completion of the "first series" only makes way for the commencement of a second. The manuscript of this is already prepared, and will be forthwith printed in five volumes as large and full as those already given to the world. Dr. Billings has taken up new duties in a different sphere of activity; but the "labour of love" which he here dedicates to international science will still be carried on under the inspiration of his singular genius. The gratitude of his innumerable debtors will be enhanced by a lively expectation of benefits to come.

OUR BOOK SHELF.

Mesures Électriques. By Eric Gerard. (Paris: Gauthier-Villars et Fils, 1896.)

TO those who are acquainted with M. Gerard's previous work ("Leçons sur l'Électricité"), the publication of the present work will probably be extremely welcome, for in it he has, in his usual clear and satisfactory style, gone more fully into the question of the measurement of electrical quantities.

In an introductory chapter, the author considers the question of the errors of observation, and the effects they have on the final result. In this discussion, that interesting branch of pure mathematics called the method of least squares for determining the probable error, and which, in the hands of many observers, seems to perform much the same function as the ink does in the case of the cuttle-fish, is left comparatively in the background. Such questions as errors of observation—properly so called—and of systematic errors are, however, dealt with, and the importance of exercising judgment in deciding the accuracy with which the different quantities have to be observed, in order that the result may be correct to within a certain amount, is insisted upon. There is one paragraph which ought to be written up as a text in all laboratories and testing-rooms, and is to the effect that in making electrical connections too much care cannot be taken in arranging the wires and in cleaning the contacts, and that connecting wires ought not to consist of long spirals, for these only serve to increase the resistance and self-induction of the circuit. Some very useful instructions as to the best method of recording observations are given, together with some hints as to choice of an algebraic function to represent a given curve.

There is also a chapter on the measurement of lengths, time, angles, forces, velocity and power; and one on photometry, a subject which, since the expiration of the incandescent lamp patent, and the introduction of the incandescent gas-lamp, has become of very great importance to the electrician.

The more purely electrical part of the book consists of chapters on electrical standards, galvanometers (including ammeters), voltmeters, coulomb- and watt-meters, and two very fairly complete chapters on the measurement of self-induction, and the magnetic properties of iron. There are also chapters on the measurements of the characteristics of motors and dynamos (both for continuous and alternating currents), and on transformers. Although the devotee to the slide-rule is probably born and not made, an appendix on this instrument may be of service to those who have not yet been initiated.

The whole book is essentially a practical and readable text-book, though, perhaps, hardly a laboratory manual of the subject; it is remarkably free from useless and uncalled-for mathematical formulæ, and will undoubtedly be found of great use. W. W.

Problems in the Use and Adjustment of Engineering Instruments. By Walter Loring Webb, C.E. (Pp. iv + 64. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1895.)

IN every college or university where field work is a subject in the curriculum, such a book as this is found to be almost indispensable. Its aim is to set out problems for each student or group of students to pursue, in order that no time shall be lost, and so that every one may have complete practice with individual instruments. For such a purpose, this is perhaps one of the most concisely written books on the subject, and it at the same time covers a large amount of ground, from single chain measurement to a preliminary railroad survey.

Besides the instruments usually noted, one is glad to see instruction with the plane table and Amsley's polar planimeter, both such very admirable instruments when used with precision, that it is remarkable their introduction is not more universal. Throughout the book, convenient forms for entering notes are shown, and there is also a short chapter on the use of the formulæ of probable error, the utility of which cannot be over-estimated.

Graphic Arithmetic. By H. D. Ellis. (Philip and Son, 1896.)

THIS contribution to the teaching of arithmetic consists of two charts, each 40 in. by 10 in., which can be mounted, or otherwise adapted to class teaching. Chart i., whole numbers, consists of a series of horizontal lines, divided by dots respectively into ones, twos, threes, &c., twelves. By means of vertical lines the multiples of 2, 3, &c., are shown on the line of ones, which is numbered from 0 to 144. In Chart ii., fractions (vulgar and decimal), the series of horizontal lines are 1 metre in length and 1 cm. apart. These lines are divided by dots into halves, thirds, &c., tenths. There are subdivisions into hundredths (cm.) and thousandths (millim). On Chart i. explanations are given of magnitude, unit, number, multiple, &c.; and on ii., of the multiplication and division of decimals, the expression of a vulgar fraction as a decimal, and several other matters. The charts are well adapted for the purpose of giving a sound grounding in the subject, so far as they go.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Sacred Tree of Kum-Bum.

THE eighth number of the *Bulletin du Muséum d'Histoire Naturelle* for 1895, which has just reached me, contains a paper by M. Édouard Blanc, entitled "L'Arbre à prières de Goumboum." This reminds me of a brief article which I contributed to NATURE in 1883 (vol. xxvii. pp. 223, 224).

M. Blanc begins his account by the remark: "Je veux parler du fameux arbre qui croît dans un monastère buddhiste, au nord du Thibet, et qui produit des lettres, des mots, des prières et autres formules religieuses, le plus souvent tracées sur son écorce et sur ses feuilles." Of the actual fact he adds, "des voyageurs européens, M. Potanine et M. Grenard entre autres, ont apporté le témoignage de leur observation directe."

It is evident, then, that the tree still exists much as Huc and Gabet described it. And M. Blanc brought back with him to Europe a branch and a portion of the trunk. He says: "Le phénomène est véritable: il existe réellement, et j'ai vu des caractères thibétains très nettement tracés sur les branches de l'arbre en question."

M. Blanc discusses the cause. He dismisses the probability of their being either natural markings or the work of insects accidentally resembling alphabetic characters. He has no doubt that they are produced artificially, probably with the aid of heat.

In 1891 Mr. William Woodville Rockhill's book, "The Land of the Lamas," appeared; in it (pp. 67, 68) he gives the following account of the tree:—

"Although I did not see the convent treasure-house and the 'white sandal-wood tree' until later, I will describe them here. In a small yard enclosed within high walls stand three trees about twenty-five to thirty feet high, a low wall keeping the soil about their roots. These are the famous trees of Kum-Bum, or rather tree, for to the central one only is great reverence shown, as on its leaves appear outline images of Tsong-k'apa. The trees are probably, as conjectured by Kreitner,[1] lilacs (*Philadelphus coronarius*); the present ones are a second growth, the old stumps being still visible. There were unfortunately no leaves on the tree when I saw it; and on the bark, which in many places was curled up like birch or cherry bark, I could distinguish no impress of any sort, although Huc says that images (of Tibetan letters, not images of the god) were visible on it. The lamas sell the leaves, but those I bought were so much broken that nothing could be seen on them. I have it, however, from Mohammedans that on the green leaf these outline images are clearly discernible. It is noteworthy that whereas Huc found letters of the Tibetan alphabet on the leaves of this famous tree, there are now seen only images of Tsong-k'apa (or the Buddha ?). It would be interesting to learn the cause of this change."[2]

I was anxious to see what could be ascertained from the leaves brought back by Mr. Rockhill. An application to my friend Prof. Sargent, at Harvard, procured me the following interesting letter:

1914 *N Street, December* 23, 1893.

MY DEAR SARGENT,—As regards the famous Kum-Bum tree, I was not permitted, in any of my visits to it, to touch the tree, but I got a lot of leaves fallen from it, some of which I gave to the British Museum (Department of Ethnology), where Franks or Read would, I doubt not, be pleased to show them to Dyer.

From what the people at Kum-Bum told me, especially in view of their reference to the big bunches of violet flowers, I *thought* the tree might prove to be a lilac.

The bark turns up on the trunk like that of a birch. Kreitner is responsible for the identification of this "white sandal-wood" with the *Philadelphus coronarius*.

The roots from which the trees I saw were growing look very old, how old I cannot say, being ignorant in all such matters, the live stems are certainly not over 15 to 20 feet in height, and 4 to 6 inches diameter at the root, and some of them look very healthy. It may be that when Huc and Gabet visited this place (in 1842, I believe) the original trunk was yet alive.

They say that "three men could not stretch around the trunk," but he adds that it was not over 8 feet high. He must refer to an old dead trunk, out of which shoots were growing. If this is not the case, we cannot have seen the same tree; that is all there is about it.

As to the "odeur exquise et qui approche un peu de celle de la cannelle," this must be hearsay, and refers to the popular belief that the tree is a sandal-wood, or else is a native simile for the odour of lilacs.

The large red flowers Huc also refers to may be violet ones. Mongol is not so precise a language, in fact certain colours which which we would call violet are invariably called red by them.

Huc mentions the curling up of the bark.

On the whole, I am inclined to think that here as throughout his book, Huc's reminiscences of facts and hearsay have misled him. He certainly could not see the image on the leaves or bark, for even the Kum-Bum lamas, to whom I mentioned my inability to detect anything on the leaves they had given me, assured me that *faith was necessary*—"as one's faith is so is the clearness of the image on the leaf."

I hope the leaves will assist in throwing some light on the question. Ever sincerely yours,

(Signed) W. W. ROCKHILL.

Sir Augustus Franks kindly sent me some of the leaves, accompanied with the following memorandum:—

"Leaves from the tsandan karpo ('white sandal-wood tree') of Kŭmbŭm, said to have sprung up on the spot where Toongkâpe's mother threw his hair when, having shaved his head, she consecrated him to the house.

"Used when ground as medicine—also carried in charm boxes.

"Collected by W. W. Rockhill at Kŭmbŭm in 1891."

They were carefully examined by Mr. W. B. Hemsley, F.R.S., Principal Assistant in the Kew Herbarium, who has long been engaged on a critical study of the Chinese Flora. He arrived at the conclusion that they belonged to *Syringa villosa*, a Chinese species. He published his determination in *Journ. Linn. Soc.* (vol. xxx. p. 133), and I am disposed to regard it as correct. It confirms the statement of Kreitner (NATURE, xxvii. p. 171).

Rockhill's identification with *Philadelphus* is a mistake easy of explanation. He has confused the popular and the scientific use of the name Syringa. Lilac is botanically *Syringa*: Syringa is botanically *Philadelphus*.

It will be seen from the accounts given above that the phenomenon is not consistent with itself at different times. This confirms the opinion of M. Blanc that it is an elaborate fraud.

W. T. THISELTON-DYER.

P.S.—I have omitted to add that Blanc says (*l.c.* p. 323): "L'arbre paraît appartenir à la famille des Phytolaccacées ou à une famille analogue."—W. T. T. D.

[1] Kreitner, "Im Fernen Osten," p. 708. I was told that in spring these trees have large clusters of violet flowers, but if they are lilacs I am astonished that the Chinese do not speak of them as such, for that shrub is well known in Kan-su and throughout Northern China (see Prjevalsky. "Mongolia," ii. 79). Tibetans call all sweet-smelling wood *tsandan* (*i.e.* sandal-wood). Sir Joseph Hooker (*Himalayan Journals*, i. 298) says that the Lepshahs and Bhoteas call the funereal cypress *tsandan*. The Kum-Bum tsandan karpo is certainly not a cypress, however.

[2] When Lieutenant Kreitner visited this place (1879), the images on the leaves were as at the present time. See "Im Fernen Osten," p 707. The Arab traveller, Ibn Batuta, saw in the fourteenth century, at Deh Fattan, on the Malabar coast, in the courtyard of a mosque, a tree called the "tree of testimony." Every year there was a leaf on it, on which was written "by the pen of divine power," the formula, "There is no God but God; and Mohammed is the envoy of God." The inhabitants used it to cure disease (see Ibn Batutah, Defrémery's Transl., iv. 85).

The Röntgen Rays.

REFERRING to two letters in your last issue, p. 388, it is somewhat disconcerting to have Prof. Röntgen's original experiment—viz. the observation of shadows thrown on a barium-platino-cyanide screen—treated as a novelty. No one at all informed can have had the least scepticism concerning the probable observation of such shadows by Prof. Salvioni, though the sensational announcement made by some daily papers, that the eye had been made "actually to see" objects inside enclosures, was received, and is still received, with complete incredulity. A protected barium-platino-cyanide screen is extremely useful as a tester of the condition of an exhausted tube, and I have constantly used it as such, in imitation of Prof. Röntgen.

That a Crookes' tube gets hot when in action is perfectly patent to the touch; so also is the electrostatic attraction of the tube for pieces of paper and the like.

The term "anode rays" for the rays discovered with so much *éclat* by Prof. Röntgen, whether they be the same as those previously discovered by Dr. Lenard or not, is suggested by remarks from Mr. A. W. Porter at a recent meeting of the Royal Society. They certainly do not start from the kathode, but from some opposed surface, a surface which may be an actual anode, and which always has some anodic properties. From each point of such a surface rays start in all directions; this is proved by the shadows they cast of slits, holes, and wires.

OLIVER J. LODGE.

I MAY state that in a lecture which I gave here on the evening of Tuesday last, the 25th ult., I showed to a large audience, by means of a sheet of barium platino-cyanide, rendered fluorescent by the Röntgen rays from a Crookes' tube, all the things referred to by Mr. Campbell Swinton in his letter in the last number of NATURE. The shadows of coins in a purse, and of a hand, were distinctly visible to the audience when placed behind screens perfectly opaque to ordinary light, and, though more dimly, even through a book of eight or nine hundred pages.

I must confess that I cannot see why, after Prof. Röntgen's account of his own work, the success of such experiments as those made by Mr. Swinton or myself should be regarded as surprising, or accounts of them received with incredulity. They seem to me to be merely a variation of Prof. Röntgen's own experiments, or at most to be a matter of the most obvious inference from these experiments.

The statements that have appeared to the effect that Signor Salvioni has devised a method of rendering the retina of the human eye sensitive to Röntgen rays, and that by his method objects are directly *seen* through planks of wood, sheets of aluminium, &c., are simply absurd. The fluorescent light produced is entirely distinct from the Röntgen rays, and affects the retina like ordinary light; and of course parts of the sheet which do not fluoresce, because they are shielded by the opaque objects behind from the Röntgen rays, appear dark. Seeing such shadows can no more be said to be *seeing the objects themselves* by means of the Röntgen rays, than a man can be said to see himself when he looks at his shadow thrown by an ordinary gas-lamp on the street.

Prof. Röntgen discovered the fluorescence of the barium platino-cyanide under the rays now called by his name, and the transparency of ordinarily opaque matter to these rays, and the discoveries of Signor Salvioni and others, so far, at any rate, as they have been described in NATURE[1] and other journals I have seen, amount to nothing more. It is only just that in accounts of verifications of Röntgen's discoveries an attempt should be made to show clearly that such observations are only verifications, so as to prevent the credit of discovery which is Prof. Röntgen's due from any appearance, however unintentional, of indirect diminution.

Scientific accounts of verifications, as far as I have seen them in NATURE or elsewhere, are in themselves unexceptionable; but extra precaution seems necessary in order that the public should not be led by newspaper paragraphists, retailing such accounts at second-hand, to regard as extensions of Röntgen's work what are only direct and obvious consequences, perceived by himself, of the facts which he has observed.

ANDREW GRAY.

University College of North Wales, Bangor, March 1.

IN your last issue (p. 399), in the account of the work appearing in the *Comptes rendus*, you state that M. de Heen "proves conclusively that the X-rays proceed from the anode and not the kathode." May I point out (as I did at the Royal Society, in the course of the discussion on Prof. J. J. Thomson's paper, February 13), that I have proved that this is undoubtedly true for the bulb that I have been using *throughout* my experiments on the X-radiation. The bulb is one in which the negative electrode is concave, and the negative stream is thereby focussed to a point on the anode, which is a platinum disc placed near the centre of the bulb. By measuring the positions of different parts of a radiograph of a series of concentric zones of tinfoil placed in a measured position, I have shown that the actinic rays diverge from the anode disc.

I am of opinion, however, that in this respect this bulb differs from those which have been employed by others. In these latter, judging from the published accounts, the negative stream impinges directly on the glass; and for bulbs of this kind, it has been shown conclusively by Prof. J. J. Thomson that the seat of the origin of the rays is the glass itself. The proof is that a sensitive plate placed inside the bulb in the path of the negative stream is not acted upon. I venture to think that, in the case of my bulb, a sensitive plate placed inside would be acted upon provided it lay in the hemisphere of the bulb in which the kathode lies. I intend to test this conjecture experimentally. Should it prove true, the behaviour of both varieties of bulb will probably be capable of description by the following single statement:—

The seat of the origin of the X-rays is where the negative stream first impinges against a solid, and gives up, or partially gives up, its negative charge.

ALFRED W. PORTER.

University College, London, February 28.

IN your "Notes" of last week you refer to a communication of M. de Heen, stating that the X-rays proceed from the anode. Some experiments, which I made at the beginning of last month, bearing on this point, may be of interest to your readers. It is of course not the case that the X-rays proceed from the anode in general, but they may be made to do so by placing a small disc as anode facing the kathode. The kathode streams impinge on the former, and the X-rays being generated there radiate from it. The experiment was made by placing a lead plate (4 cm. by 10 cm.), with a rough circular hole in it, at a distance of 10 cm. above the photographic plate, and the tube (a small one with a curved kathode facing a small disc anode) 10·5 cm. above the lead. After development the negative was replaced exactly in its former position. Several interesting facts showed themselves, the most striking being that the image of the hole consisted of a well-defined circle showing even individual splinters on the edge, and in addition diffused elongation on two sides. On placing the eye so that the hole exactly covered its well-defined image, it was necessary to put it in the position occupied by the anode.

The diffused images in the same way were seen to be due to the fluorescent parts of the glass sides of the tube—a kind of pin-hole photograph, in fact.

The rays leave the anode as if they were the splash of a jet of water occupying the position of the kathode stream. In other words—supposing the plane of the anode vertical and the kathode to the right, then no rays appear to the left of the plane of the anode, whilst on the right the space is exceedingly rich. The negatives show, in every case tried, two well-defined regions, viz. nothing to the left of the intersection of the plane of the anode with the negative, and a dense deposit on the right, the richest part apparently being close to this line. It is difficult to account for this on the supposition that the rays are due to waves generated at the point of impact. We should expect in this case the action on the plate to increase with the visual angle of the anode disc as seen from points on the plate. On the other hand, certain further experiments seem to show that the action is not in all respects similar to the splash of a jet. Whether the effect is due to the fact that the place of impact of the kathode stream is an anode, or simply an internal obstacle, I have not yet determined, but experiments in progress will, I hope, settle this point.

For photographic purposes, the best kinds of tube are those with a curved kathode converging the streams on a small plane anode, remembering, of course, that the strong field is on the kathode side of the anode plane. This behaves very approximately as a radiating point. With this I have obtained, with comparatively short exposures, and a $2\frac{1}{2}''$ to $3''$ spark length, strong negatives of remarkable definition, certainly finer than any I have yet seen.

W. M. HICKS.

Firth College, March 1.

I WAS interested to see in your last issue a letter from Mr. Swinton describing his reproduction of Prof. Salvioni's experiments with phosphorescent screens. Mr. Swinton uses a piece of blotting-paper impregnated with platino-cyanide of barium. I have tried this method, but have obtained better results with a screen prepared with the same salt, as follows:

A piece of fairly stout black paper, free from pinholes, is coated with gum containing a little glycerine, and, as soon as it has

[1] A translation of Prof. Salvioni's paper will be found in another part of this issue.—ED. NATURE.

got tacky, it is dusted over until covered with the barium platino-cyanide, which has been finely powdered.

Greater distinctness is obtained by this method, insuring, as it does, a thin but compact layer of crystals, unseparated by the fibres of the blotting-paper. J. William Gifford.

Chard, March 1.

Crush-Conglomerates in Ireland.

On the sea-coast at Portraine, Co. Dublin, there is an apparent thickness of over 700 feet of conglomeratic rocks, which have hitherto been regarded and described as of volcanic origin, contemporaneous with the Lower Silurian strata and associated felspathic igneous rocks.

This conglomerate is massive in character, and exhibits a structure resembling rude bedding. It consists of sub-angular and rounded blocks and pebbles of grey fossiliferous Bala limestone, calcareous grit, and occasional lumps and fragments of crushed felsite, the whole being enveloped in a brownish-grey argillaceous and calcareous matrix.

The Lower Silurian section here shows grey limestone passing upwards into alternations of grit, limestone, and argillaceous shale, with thick bedded calcareous mudstones at top, the whole series being more or less fossiliferous.

The associated igneous rocks are intrusive basic felsites of several varieties, and, like the sediments, present evidence of intense crushing.

Having had assigned to me, in the Geological Survey, the revision of the Silurian tracts in this part of the east of Ireland, I spent some time on the ground last summer, and was led to form the conclusion that this supposed conglomerate is not of volcanic origin. The work has not yet been officially inspected, but I am enabled, with the sanction of the Director-General, to state here briefly the results at which I have arrived.

I believe that instead of volcanic detritus contemporaneous with the deposition of the Silurian strata, we have here a vast crush-breccia or crush-conglomerate, formed by the breaking-up both of the Lower Silurian sediments and the igneous rocks, along particular zones of earth-movement, and a flowing and subsequent re-cementing together of the broken-up and rolled fragments. So far as I could judge, there are no truly contemporaneous igneous rocks in the district.

Where the intrusive rocks have come within the region of intense squeezing, they are sheared and ground into more or less powdered masses, having a resemblance to volcanic material, and this probably gave rise to the supposition that they were volcanic.

The breaking-up of the hard bedded rocks can best be studied at the south end of the section, and in some cases the beds of limestone and grit can be seen, as it were, in the process of being broken up into detached pieces, the fragments rolling off through the mudstones.

The conditions at Portraine are repeated exactly on Lambay Island, three miles off, but apparently on a grander cale.

I consider this crush-conglomerate rock-structure to be of great importance in connection with many more supposed volcanic areas of Silurian age in Ireland.

Alex. McHenry.

Geological Survey Office, Dublin, February 28.

Science and Morals.

All who are engaged in extending the boundaries of natural knowledge will be interested in the remarkable letter of Prof. Ramsay, in last week's Nature, on the moral claims of original discoverers in relation to the work of subsequent investigators in the same field of research. As one whose experience is of sufficient duration to stand in both these relations, I should like to point out several objections to the position assumed by Prof. Ramsay on this question.

In the year 1866 I announced before the Royal Society the discovery that quantities of magnetism and electricity indefinitely small would induce quantities of these forces indefinitely great, and demonstrated the same, on a large scale, by means of a small magneto-electric, acting in conjunction with a large dynamo-electric machine.[1] The discovery excited considerable interest at the time, and my experiments were repeated by many electricians in Europe and America. Among these were Varley, Wheatstone, Siemens of Berlin, and Farmer in America, who soon found that the residual magnetism of an electro-magnet was sufficient to supply the initial current required for exciting the dynamo; thereby dispensing with the permanent steel magnets of the magneto-electric machine. Although I had actually made experiments in the same direction some time previous to the announcement of my discovery, it never occurred to me, before reading Prof. Ramsay's letter, that I have all these years been a martyr to the injustice inflicted by unscrupulous electricians publishing, without my consent, the happy invention of the self-exciting dynamo machine.

The work of an original discoverer, though popular, is not unfrequently of a very subordinate character; increasing, in some cases, the value and importance of previous discoveries, or preparing the way for still greater ones, which the original investigator may be quite unable to deal with. The pretension set up by Prof. Ramsay, with its personal application, that the permission of an original discoverer should be obtained before the results of subsequent researches in the same field by other workers are published, strikes at the root of all scientific progress, and indicates a simplicity of character rarely to be met with in those engaged in philosophical pursuits.

Prof. Ramsay is again unfortunate in his analogy between the moral questions involved in a scientific discovery and in a patented invention. Law and equity alike encourage the publication of subsequent improvements on original inventions *without the consent of the first inventor*, and only intervene and censure when the right and title *to his own invention* are impugned.

The morality of Prof. Ramsay would suppress all investigations on the Röntgen rays, now being made wherever science is cultivated, or would render it impossible for the original discoverer to consider the numerous applications for permission to publish the results of further experiments.

The policy of secrecy and procrastination suggested as a corrective to the activities of subsequent investigators is not likely to meet with the approval of scientific men who have in mind the history of the discovery of the planet Neptune, and the rival claims of Adams and Leverrier. A great master of science (Sir George B. Airy) has well said with reference to this and other discoveries, "that it is advantageous for the progress of science that the publication of results, when so far matured as to leave no doubt of their general accuracy, should not be delayed till they are worked to the highest imaginable perfection."

February 25. Henry Wilde.

[1] *Proc. Roy. Soc.*, 1866; *Phil. Trans.*, 1867.

Inverted Images.

In connection with the view advocated by Mrs. Scott in your last number, it may be of interest to state that, in my own personal case, I have been able all my life to read a book with the greatest facility upside down; it making not the least difference to me which way it is presented. I am told—but this is not within my personal recollection—that I learned to read by looking over the book of an elder brother who was being taught in the usual way, standing in front of him, not behind. The singular circumstance to my own mind is that I have precisely the same facility in reading upside-down books written in any foreign language with which I may be more or less acquainted, in which the letters differ from the English, as Greek and Hebrew; and the facility extends, to very nearly the same extent, to handwriting. I have never at any time practised it systematically; it appears to come perfectly naturally.

Alfred W. Bennett.

Remarkable Sounds.

A peculiar sound, apparently similar to the "soughing of the wind" (see p. 78, *ante*), is briefly described by Liu Wan-Ping, a Chinese Commodore, in his journal of voyage made in 1595 from Cheh-Kiang to Shan-Tung, in order to defend the latter province from the attack by the Japanese fleet. (Sie Tsai-Kang's "Wu-tsah-tsu," Japanese edition, tom. iv. fol. 46, *a*.) The passage is as follows: "Same night we anchored near Fuh-shan-tau [in Shan-Tung]. This mountain, as if inhabited by a deity, utters a voice sounding mournfully, although on it neither herb nor tree exists, and neither hollow nor cavern therein." Kumagusu Minakata.

February 8.

THE SHIFTING OF SPECTRAL LINES.

I.

THE *Astrophysical Journal* for February contains some papers of the highest interest, touching small variations in the wave-lengths of spectral lines and the causes which produce them. These are stated to have been, in the first instance, established by Mr. Jewell by an examination of the Rowland series of photographs of the solar and metallic spectra taken by means of a concave grating of 21½ feet radius and 20,000 lines to the inch—an instrument of research which, so far as my own experience goes, is not to be obtained by workers in this country.

Mr. Jewell's investigations began in 1890. Another paper by Messrs. Humphreys and Mohler details the results of work begun last year on the effects of pressure on the arc spectra of the elements, work suggested by Mr. Jewell's prior researches.

Mr. Jewell has, as a basis for his new conclusions, practically studied under modern conditions classes of phenomena which I was the first to observe and describe, as near as may be a quarter of a century ago.

To show the relation of the new work to the old, it is best to begin with a short historical statement, which will have the advantage of giving to non-experts an idea of the meaning of some of the terms employed.

I first employed the method of throwing an image of a light source on to the slit of a spectroscope by means of a lens in 1869, and some of the results obtained by the new method were the following.

(1) The spectral lines obtained by using such a light source as the electric arc, were of different lengths; some only appeared in the spectrum of the core of the arc, others extended far away into the flame and outer envelopes. This effect was best studied by throwing the image of a horizontal arc on a vertical slit. The lengths of the lines photographed in the electric arc of many metallic elements were tabulated and published in *Phil. Trans.*, 1873 and 1874.

(2) The longest lines of each metal generally were wider than the others, the edges fading off; and they reversed themselves; by which, I mean, that an absorption line ran down the centres of the bright lines. These results were afterwards confirmed and extended by Cornu ("Chemistry of the Sun," p. 379).

(3) From experiments with mixtures of metallic vapours and gases, it came out that the longest lines of the smaller constituent remained visible after the shorter lines had disappeared, the spectrum of each substance present getting gradually simpler as its percentage was reduced,[1] the shorter lines being extinguished gradually. Shortly after these observations were made, I included among some general propositions:[2] "In encounters of dissimilar molecules the vibrations of each are damped."

(4) The various widths of the lines, especially of the winged longest ones, were found to depend upon pressure or density, and not temperature.[3]

(5) The "longest lines" of any one metal were found to vary in their behaviour in most extraordinary fashion in solar phenomena, being furthermore differentiated from the shorter ones; and on this and other evidence I founded my working hypothesis of the dissociation of the chemical elements at the solar temperature. In 1876 I set out the facts with regard to calcium.

(6) In 1883, Prof. W. Vogel, in a friendly criticism, pointed out the evidence then beginning to accumulate, that under certain circumstances the wave-lengths of lines are changed.[4] In 1887, I extended this evidence,[5] and I think it was I who coined the word "shift" to express these changes.[1]

I now pass on first to the results which Mr. Jewell claims to have established.

With the enormous dispersion produced by the instruments referred to, it is found that certain metallic lines, but not all, are displaced or "shifted" towards the violet when compared with the corresponding solar lines. "There was a distinct difference in the displacement, not only for the lines of different elements, but also for the lines of different character belonging to the same element."

The "different character" above referred to turns out to relate not so much to the intensity as to the length, and, associated with this, the reversibility of the lines; the longest lines are the most displaced, the shortest, least.

Further, in the spectrum of the arc itself, the position of a line with but little material present "was approximately the same as the position of the line when reversed." Now since the longest lines are most displaced to the violet, this means that the smaller the quantity of a substance present the greater is the displacement towards the violet; and therefore the greater the quantity present, the greater the displacement towards the red.

Further on, Mr. Jewell expressly states "it was found that with an increase in the amount of the material in the arc there was an increasing displacement of the line towards the red," and then he adds, "unless the line became reversed, when all further progress in that direction ceased."

Here is an observation regarding the red line of cadmium. "It was found that if the micrometer wires were set upon it with very little cadmium in the arc, then as the amount was increased the line almost bodily left the cross-hairs, always moving towards the red."

Mr. Jewell considers he has established that the vibration period of an atom depends to some extent upon its environments. "An increase of the density of the material, and presumably an increase of pressure, seemed to produce a damping effect upon the vibration period."

My result of 1872 with regard to pressure is endorsed, "the new results are found to be due to pressure and *not* temperature."

We seem then now to be in presence of two damping effects in the case even of metallic lines, one which extinguishes lines when we deal with dissimilar molecules, and one which changes their wave-length towards the red when we deal with similar molecules.

A carefully prepared table is given by Mr. Jewell, showing the origin, intensity and character of the solar lines considered, the intensity and character of the corresponding metallic lines, the wave-lengths of both, and the observed displacement.

There are many references to solar phenomena in Mr. Jewell's paper, but I do not propose to discuss them now. There is one point, however, I must refer to, in justice to my critics. He considers that the conclusions to be drawn from a study of the new shifts "effectually disposes of the necessity of any dissociation hypothesis to account for most solar phenomena." I have already pointed out that this was Prof. W. Vogel's conclusion with regard to possible shifts, so far back as 1883.

It is quite easy. "Two adjacent lines of iron, for instance, may show the effects of a violent motion of iron vapour in opposite directions, in the neighbourhood of spots, or one line (the smaller one corresponding to one of Lockyer's 'short lines') may show a broadening and increase of intensity in the spectrum of a sun-spot,

[1] *Phil. Trans.*, 1873, p. 482.
[2] "Studies in Spectrum Analysis," 1878, p. 140.
[3] *Phil. Trans.*, 1872, p. 253.
[4] NATURE, vol. xxvii., 1883, p. 233.
[5] "Chemistry of the Sun," p. 369.

[1] Since the parentage is uncertain, I may say that perhaps "shiftings" would have been a better word, as shift is otherwise employed, *e.g.* Love's last shift (translated by a French author, *la dernière chemise de l'amour*).

while the other line (the larger one corresponding to one of Lockyer's 'long lines') is unaffected. But this does not prove that iron vapour is dissociated in the sun. It merely shows that the apparently similar portions of the two lines in the solar spectrum are produced at different elevations in the solar atmosphere. The stronger iron line will be affected in a sun-spot as much as the other one, but it is the portion of the line produced at the same level as the other line, and may be masked completely, or very largely, by the emission line produced at a higher level, while the second absorption line in the solar spectrum may be entirely unaffected, being produced at a still higher altitude."

"This also explains why some of the lines (the short lines generally) of an element may be most prominent in sun-spot spectra, while others (generally the long lines) are those most frequently seen in prominences or in the chromosphere."

My thirty years' work at solar physics leaves me with such an oppressive feeling of ignorance that I willingly concede to Mr. Jewell a knowledge so much greater than my own as to give him a perfect right to dismiss all my work in two lines; but I am compelled to point out that he has not carefully read what I have published.

A comparison of the facts brought together in Figs. 112 and 114 of my "Chemistry of the Sun," for instance, drives his last paragraph into thin air: it is distinctly shown that we have to do with the short lines in the chromosphere and with the long lines in spots, the exact opposite of his statement. Mr. Jewell is not running counter to my views in supposing that different phenomena are produced at different elevations. I thought I had abundantly proved in my eclipse observation of 1882 ("Chemistry of the Sun," p. 363), that the iron lines, to take a concrete instance, are produced at different heights in the solar atmosphere; and that was one among many reasons which compelled me to abandon the thin reversing layer suggested by Dr. Frankland and myself in 1869 in opposition to Kirchhoff's view; but surely the more we consider the solar atmosphere as let out in flats, with certain families of iron lines free to dwell in each and to flit *à discrétion*, the more a dissociation hypothesis is wanted. And beyond all this, we have to take into account that at the sun-spot maximum no iron lines at all are seen amongst the most widened lines, while at the minimum we have little else.

Another very interesting part of Mr. Jewell's paper refers to the phenomena of absorption. There is room for plenty of work here. As I pointed out in 1879, we get unequal widenings, "trumpetings," and a whole host of unexplained phenomena.[1] It is clear that the enormous dispersion at Mr. Jewell's command will largely help matters.

I now pass to Messrs. Humphreys and Mohler's paper.

Messrs. Humphreys and Mohler have used an electric arc enclosed in a cast-iron cylindrical vessel, which enabled them to vary the pressure up to fourteen atmospheres. One hundred photographs have been taken, and the shifts of some lines of twenty-three elements have been measured. The accompanying rough diagram, bringing together specimens of their observations, will indicate the kind of result they have obtained.

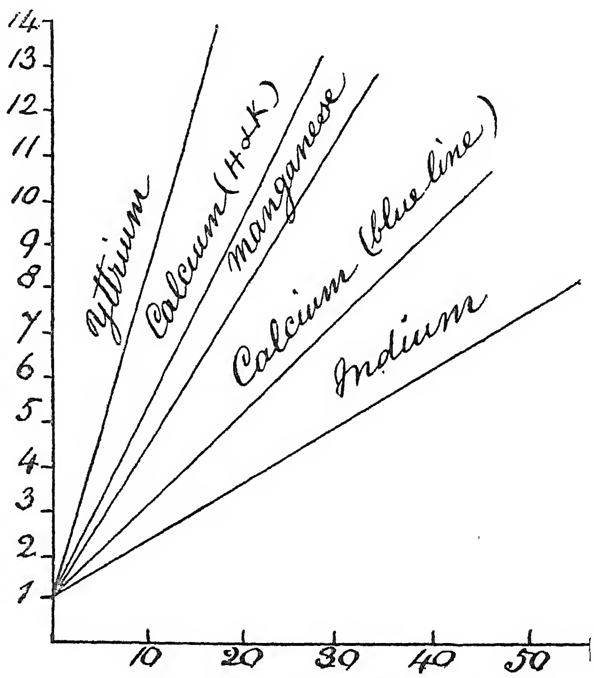
The pressures in atmospheres are shown to the left. The shift towards the red in thousandths of an Angström unit are shown below. The shifts have been reduced to what they would be at λ 4000, in the neighbourhood of which most of the work was done. I must refer to the paper itself for the method of measurement adopted.

The displacement or shift varied greatly for different elements. It was always towards the red, and directly proportional to the wave-length and the excess of pressure over one atmosphere.

Only one exception to this general statement is given; it refers to calcium. "The lines H and K, among others, shift only about half as much as *g* (the blue line at 4226), and the group at wave-length 5600. That *g* should differ in this respect from H and K is not very surprising, since it is known to differ greatly from them in many other respects."

On this exceptional behaviour of these lines of calcium, I quote the following, from a note by Prof. Hale, which appears in the same number of the journal.

"The difference in behaviour of H and K and the blue line of calcium discovered by Messrs. Jewell, Humphreys, and Mohler, seems to support Lockyer's views as to the dissociation of calcium in the arc and sun. The remarkable variations of the calcium spectrum with temperature have long been known principally through the investigations of Lockyer. The writer has shown that the H and K lines are produced at the temperature of burning magnesium and in the oxy-coal-gas flame. They could not be photographed in the spectrum of the Bunsen



burner, though an exposure of sixty-four hours was given. Since these experiments were made, I have been informed by Prof. Eder that his own efforts to photograph the lines in the Bunsen burner were no more successful, though an optical train of quartz and fluor-spar was employed. It would thus appear that the temperature of the dissociation of calcium is between that of the Bunsen burner and that of the oxy-coal-gas flame. The high molecular weight of calcium has hitherto conflicted with our belief in the presence of this metal in prominences. If, however, it be granted that dissociation can be brought about by temperatures even lower than that of the arc, the difficulty is very greatly lessened."

I may add that it will be very interesting to see if the strontium line at 4607 behaves like the calcium *g* in relation to the lines at 4077 and 4215 representing H and K.

I have said enough in the present paper to show the extreme importance of these new results. So much care has been taken, that there is little doubt that subsequent

[1] "Chemistry of the Sun," pp. 380-387.

work will confirm them; and when this is done, students of spectrum analysis will find a new region of the highest importance open to their inquiries.

J. NORMAN LOCKYER.

(*To be continued.*)

THE VARANGERFJORD REGION AND THE FORTHCOMING SOLAR ECLIPSE.

WE expect to have during this summer a good many visitors to the far north of Norway under the 70th parallel of north latitude, and close to the frontier of Russia. The total eclipse of the sun on August 9 (a few minutes before 5 a.m.) will attract many astronomers to these high latitudes. The sun will rise only 14° above the horizon during the eclipse, but the mountains here are not so high as to prevent the selection (though with some little difficulty even on the fjords) of places where their height will not prove an obstacle to the observers. In case one is in doubt, our official almanac gives the time when the sun will be visible on May 3; add nine minutes to that time, and it will be the time when the sun will rise over the mountains at the particular place.

It will be more difficult for astronomers to get a clear sky. The neighbourhood of Vardö, which otherwise would be very suitable, is plagued with fogs in the summer. Vadsö has more advantages, but still better are such inland places as Polmag, Utsjoki, Karasjok, Kautokeino, and Karasuando (in Sweden).

I shall give here some information for the guidance of those who intend to visit this remote corner of the earth.

The Varangerfjord ("ng" pronounced as in singer, not as in anger) runs inland west-north-west; the land lying north of it is called the Varanger Peninsula, and that to the south of it South Varanger. All the land is fjeld (mountainous land, highlands), but it rises nowhere to any great height. There are no good maps of this region, except of the eastern part of South Varanger, of which the Government recently published a map on the scale of 1 in 100,000; it is the best map. There is also the ethnographical map of Finmark, by Friis, scale 1 in 200,000 (Christiania, 1888). On this remarkable map every family is indicated by a separate mark; it indicates also the language they speak, and gives other details. It is, naturally, only in such a very sparsely populated region that such minute details can be represented on a map.

The Varanger Peninsula is a plateau which on its western border attains a height of 2200 feet, and on its southern about 1500 feet. The plateau is, however, not quite level, but presents such long, gentle undulations as are seen on the open ocean in calm weather. The permanent population, which keeps to the sea-coast, has here and there some outlying fields in the open parts of the valleys near the sea.

With the exception of these and the immediate neighbourhood of the settled places, the whole region consists of rolling mountain-tops practically unknown to the civilised world. It can, according to all that we know of it, be described as a wilderness of rocks, a stony desert covered here and there with reindeer moss (*Cladonia rangiferina*), and some swampy places where there thrives a scanty vegetation of green plants. Towards the inner part of the Varangerfjord there are some stretches of damp ground, overgrown with dwarf willows. About the centre of the peninsula are some large lakes full of fish, which only a few Norwegians have visited. However, access to them (apart from the question of distance) is not difficult from the south, for although there is no road, one can be driven there in a little cart. In winter, a few clever snow-shoe skaters have crossed this completely desolate, uninhabited land from north to south, a distance of forty English miles.

The western side of the Varanger Peninsula has a steep coast-line, but between Vardö and Vadsö the slope of the land seawards is very gentle; to those who sail along the coast the country seems quite level.

The appearance of the coast at Vardö is seen in the illustration on p. 418, desolate and dreary, truly an Arctic desert land; to the right is a bay of the sea, and the flat land in the foreground, consisting of gravel, exhibits some characteristic curved lines; they are raised sea-beaches. Probably one must go to the great lakes of America to find equally brilliant examples of former water-levels. The uplifting of the land has not been uniform. On the north side of Varanger Peninsula the old beaches are 70 feet above tide, but on the south, at Vadsö, they have been raised to between 260 feet and 295 feet. Probably the land is rising at the present time. In Vardö, old people point out quays which have risen several feet during their lifetime. The Austrian astronomer, Pater Hall, who came to Vardö in 1769 to observe the transit of Venus, was so much interested in this question, that he caused a little pillar to be erected, the height of which above the then existing tide-level was accurately determined. He inserted in the parish register of Vardö a description of the position of this pillar; but, alas! though the register is still in existence, the pillar has disappeared. The land on the south side of Varangerfjord, South Varanger, is not quite so bleak and bare as Varanger Peninsula; it has some pine forest in the valleys. It also can be considered a plateau; but it is furrowed by valleys and fjords, and is thereby broken up into a multitude of small, flattish, dome-topped mountain masses. The plateau character is shown by the fact that all the mountains rise to about the same height; in the eastern part, near the sea, to about 1300 feet.

These differences in the landscape and in the character of the country are connected with the fact that there are not the same kinds of rocks on the south side of the fjord as on the north side; probably there is a line of faulting along the fjord. On the south side there are Archæan gneiss and granitic rocks; on the north side younger rocks (conglomerates, sandstones, and slates), probably of Cambro-Silurian age; but fossils have not as yet been discovered in them. A remarkable conglomerate occurs in the inner part of the Varangerfjord; it may have been formed during a very remote Glacial period, probably Cambro-Silurian. It contains striated boulders, and rests partly on an underlying bed which shows glacial striations.

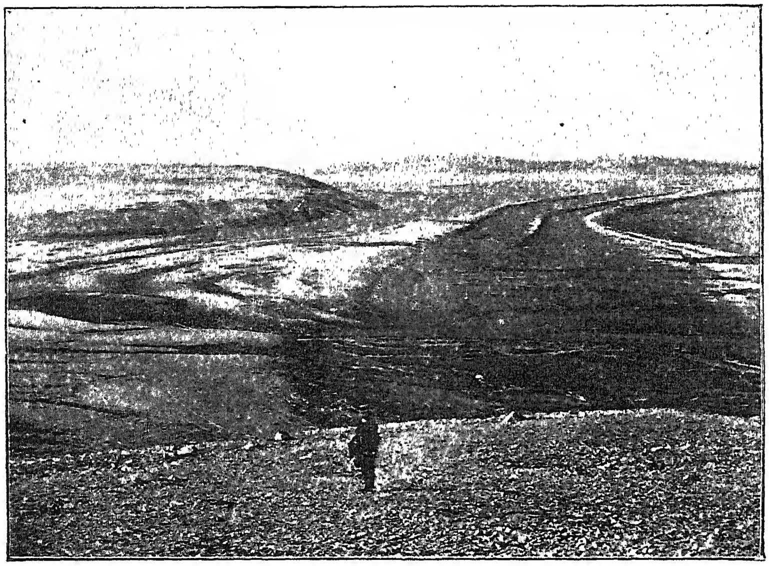
We shall now take a glance at the inhabitants of this province, Finmark, which touches the Russian frontier. The Norwegians gradually migrated into it during the last few centuries, but the Laps were already there. Many of the Laps wander as nomads with their reindeer, and dwell in tents, but the greater part of them live on the sea-shore, poor fishermen and farmers (like the crofters in the isles of Scotland), who grow a little hay for their cattle, and a few potatoes for themselves. There are no cereals in this northerly province.

Many of the inhabitants live in wretched earth-huts, which they share with their cattle. The Fins, who came from the grand-duchy of Finland, were the last to migrate into this district. The immigration commenced more than a century ago; it attained its maximum between twenty and ten years ago, and it is now decreasing. The language of the Laps differs about as much from that of the Fins as English differs from German; the Norsk language, as is well known, belongs to another group, the Germanic. All the three races are Lutherans. Finmark is very thinly peopled; the whole population in 1891 was 23,000 on an area of 47,000 square kilometres, or about two square kilometres to each individual. Finmark

has three small towns, Hammerfest, Vardö, and Vadsö, each with about 2000 inhabitants; the last two are spoken of as astronomical stations; in both there are small second-class hotels, at which the charges are about five shillings to six shillings a day. In Vardö, Hansen's hotel, and rooms may be had from Herr Holte, the baker, and Herr Ness. In Vadsö, Krog's hotel, and rooms from Herr Lindseth. The charges for labour and assistance, such as men to row a boat or to carry things, are rather high in the summer-time in the whole of Finmark, because work is plentiful and labourers are scarce.

Vardö lies on a little island in the Arctic Sea, but quite close to the mainland; it has a more rigorous climate than any other town in Norway; not the smallest tree will thrive upon the island. Sea-fogs in summer, and the tremendous storms of winter, that never cease for a single day, are not at all cheering. It is not surprising that business people there live with their families in Christiania in the winter, and in summer follow the birds of passage to the north.

Vardö's sole source of income is derived from fishery, and fish is cheap; haddock in the season sell at 6 lb. for a penny. A manufactory was started here to make dried fish meal from the flesh of this fish, but the people did not succeed in trying to remove the peculiar odour of dried fish from the material, so they were obliged to convert their works into one for the manufacture of damped fish-balls.



View of the coast at Vardö, East Finmark.

The only entertainment that I can recommend is the Russian vapour bath; it is a primitive installation. The vapour is produced by throwing water on heated stones, and the two women attendants whip the bathers with a bunch of quick-beam rods (*Pyrus aucuparia*). After the bath they offer, gratis, the Russian national drink, kvas, which tastes like ale mixed with water. However, Vardö has made progress in some respects within the last half-century. It was at that time, owing to the slowness and irregularity of the means of communication, so thoroughly out of touch with the world, and even with Christiania, the capital, that the commandant of the miniature fortress, who gave instructions to his orderly that the news from the capital should be laid before him every day, duly received them, but, alas, they were a year old!

Vadsö lies on the mainland on the northern shore of the Varangerfjord. The neighbourhood is a quite treeless pasture. The houses, like those in Vardö, are of wood, small and plain. On a little island opposite the town lies a now abandoned whaling station. Whale fishing began in the Varangerfjord; but reckless over-fishing has driven the whales from this locality, and one can foresee the time when whale fishing will be a thing of the past in the whole of Norway. From Vadsö there is a good driving road to the west, past the little town of Nessby, as far as Seida on the river Tana.

Other places which may be mentioned as stations for observing the eclipse are Polmag, Utsjoki, Karasjok, Kautokeino, and Karasuando. The first three may be reached by the steamer, which enters the Tanafjord between sixty and seventy miles east of the North Cape, and sails in a southerly direction and touches at Vagge, thirty-five miles from the mouth of the fjord. Vagge lies near the mouth of the Tana River, and close by is Guldholm, near Tana Kirke, where boats may be hired for rowing up the river to Polmag, Utsjoki, and Karasjok. At Tana Kirke (church), as well as at Vardö and Vadsö, there are telegraph stations, where astronomical time may be received from Christiania Observatory, but not at Polmag, Utsjoki, Kautokeino, nor Karasuando.

Prof. Dr. H. Mohn and Mr. Schroeter, from Christiania University, will probably take their stations at Vadsö and Bugönes, close by. In Polmag the inhabitants are the most civilised of the Laps; they live in wooden houses, and are comparatively cleanly. A party of observers may live here for some time if they bring provisions with them.[1]

In Karasjok, and, so far as I know, in Utsjoki also, one will get a friendly reception and good food from the shopkeepers. In Karasjok there are about 250 inhabitants, including a clergyman; in Polmag, not so many; but how many in Utsjoki (which belongs to Finland), I do not know. The way to Kautokeino, where living can be had at the Norwegian shopkeeper's, is by steamer to Alten, then forty miles on horseback, and seventy miles on the river by boat, which must be ordered in advance. From Kautokeino one may proceed to the village of Karasuando in Sweden, which also is within the boundary of totality, by taking a boat on the river for fifteen miles, and then on horseback or by walking for thirty-five miles more.

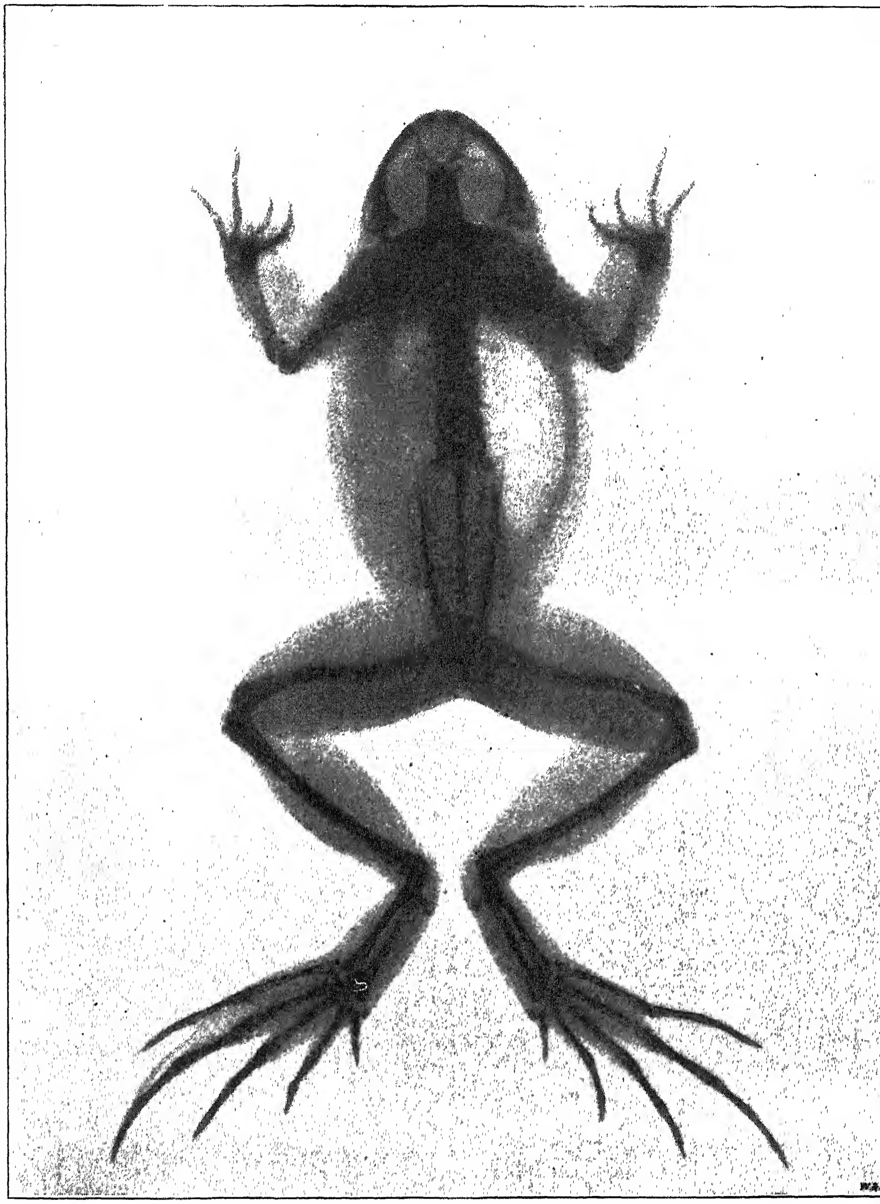
Another less generally known way of reaching Karasuando, because it is newer, is by steamer twice a week from Tromsö to Skibotten on Lyngenfjord, where comfortable accommodation can be had, thence by road thirty-six miles to Lake Kilpisjärvi (half-way to which is the not very comfortable stopping-place Helligskogen), then by rowing-boat to Muotkavuoma in Sweden, and then by road to Karasuando. The return journey from here may be made either by Vitangi to Gellivara railway station, about 100 miles, or by the much-frequented route down the river Tornea to Haparanda on the Gulf of Bothnia.

Hans Reusch.

[1] As the brown (rye) bread in general use in Norway is badly baked and most unpalatable to those unaccustomed to it, and as white (wheat) bread can rarely be had, especially in such places, a supply of biscuits should be taken

THE RÖNTGEN RAYS.

WE beg to send you a negative of a frog taken by Prof. Röntgen's method. The clearness with which the several bones have come out is so remarkable, that we consider the picture well worth reproduction, and trust you will find space for it. The larger transparent patch upon one side of the vertebral column is due to a distended lung, its collapsed fellow being evident upon the opposite side (this was proved by subsequent dissection). If you will carefully look into the larger transparent patch, you will see that the reticulated structure of the lung is evident, but we fear is too slight to bear reproduction by photo-mechanical means.



The negative was obtained by means of a small induction coil (2-inch spark) directly connected to a highly exhausted simple cylindrical Crookes' tube.

E. WAYMOUTH REID.
J. P. KUENEN.

NOTES.

THE Croonian Lecture of the Royal Society will be delivered on March 12, by Dr. A. D. Waller, F.R.S., who has selected for his subject, "Observations upon Isolated Nerve."

WE understand that the editing of the "Icones Plantarum" has passed from the hands of Prof. Daniel Oliver to those of the Director of the Royal Gardens, Kew.

WE learn from *Science*, that an endeavour is being made to establish a permanent scientific head for the U.S. Department of Agriculture. An amendment to the Agricultural Appropriation Bill has just been sent to Congress providing for a "Director-in-Chief of scientific bureaus and investigations, to serve during good behaviour, to have authority to act as Assistant Secretary, and to perform such other duties as the Secretary may direct." This amendment is, we understand, the outgrowth of an effort

to secure a permanent non-political organisation and administration of the various bureaus and divisions engaged in the scientific work of the Government, and at the same time bring about a more intelligent and more effective cooperation than has been heretofore possible. The Department of Agriculture as at present organised comprises a large number of scientific and administrative divisions having for their object the discovery, exploration, and development of the agricultural and other natural resources of the country. The scientific divisions are engaged in researches requiring the highest technical skill, and some of them in the solutions of problems requiring long years of preparation and scientific training. Our contemporary adds that, should the amendment become a law, it is by no means improbable that other scientific bureaus of the Government will seek the protection and support provided thereby, and that in the near future the United States may boast of a National Department of Agriculture and Science.

The Russian National Health Society is reported by the *Lancet* to be making strenuous efforts for the success of the Jenner centenary celebration to be held in May. Although the method in which the Society proposes to commemorate Jenner's great discovery has already been referred to in these columns, a statement of the first arrangements will be of interest. There are offered four prizes, the first equivalent to 100 guineas, and a gold medal, for the best work upon vaccination. English is one of the languages in which the work may be written, and the work must be sent in before March 12 (New Style). An exhibition of relics of Jenner, and of books, pamphlets, prints, tabular returns, instruments, and other objects relating to vaccination or to Jenner will be held. The Society is also publishing a history of the development of vaccination in Russia and other countries, and a full biography of Jenner, together with a portrait, and copies of his drawings. The price of this "centenary edition" which will be edited by Dr. Ladislas Hubert, the Secretary of the Society, will be three roubles (about 6*s.*). All objects intended for the exhibition, as well as any other communication relating to the centenary, should be addressed either to Dr. Hubert, 15 Dmitrofski Pereoulok, St. Petersburg, or to Dr. F. Clemow, 69 Earl's Court Square, London, S.W., who is acting for the Society in England.

Reuter's correspondent at St. Petersburg states that the subjoined telegram from Irkutsk was received there on Tuesday:—The Governor of Irkutsk, in reply to inquiries, has received the following from Yakutsk: "Peter Ivanovitch Kuchnareff, who trades at Ust Yansk, by a letter dated November 10, communicated the following to the merchant Kuchnareff at Yakutsk:—'We learn that Dr. Nansen's expedition has reached the North Pole, has discovered a hitherto unknown land, and has now returned.'" In order to verify the news and in case of necessity to render assistance to the expedition, the Governor of Yakutsk has instructed a member of the administration in the Verkhoyansk district to proceed to Ust Yansk.

A brief summary of the facts concerning the Panama Canal, together with a few words as to the present status of the canal construction, are given in the February number of the *National Geographic Magazine*, by Mr. R. T. Hill. So many misstatements are made as to the condition of the works, that Mr. Hill's article, and the illustrations which accompany it, will do good service in refuting them. It appears that the plant of the Company is not undergoing the ruinous decay that has been represented, both in this country and America, but, on the contrary, it is kept in scrupulously good order, and will be available for the completion of the work, should the Commission which has to report upon the affairs of the late Company decide to carry out the scheme. That the Commission does not consider the route impracticable is attested by the fact that they have kept the work progressing, about two thousand labourers having been employed upon the construction of the canal during last year. When, in February 1895, Mr. Hill took the photograph reproduced as an illustration to his article, he counted five locomotives at work carrying away the excavations from the Culebra summit. It was reported recently that the money to finish the work on the present plan has all been furnished, and that two thousand more men from Jamaica and other West Indian islands are being collected, the intention being eventually to increase the force to six thousand men. It is expected that the work will be completed in six years.

With reference to excavations of the island of Philae, the Cairo correspondent of the *Times* writes, under date February 17:—"The work of clearing the island of débris so as to permit a thorough examination of the ancient monuments, which was entrusted by the Egyptian Government to Captain Lyons, R.E., will probably be completed next month. The satisfactory discovery has been made that the foundations of the main temple of Isis are laid upon the granite rock, being in some places over 21 feet in depth, and the temple has nearly as much masonry below ground as above. The south-eastern colonnade has also its foundations upon the granite, and, so far as excavated, they are curious if not unique in design. They consist of parallel cross walls some metres high, but varying according to the slope of the rock surface, with large stone slabs placed horizontally upon their tops, and the pillars forming the colonnade are erected upon the slabs. The nilometer is marked in three characters—Demotic, Coptic, and another much older, probably Hieratic, of which a copy has been sent to Berlin for decipherment. A stela was found bearing a trilingual inscription in hieroglyph. No traces have been discovered of any buildings anterior to the Ptolemaic periods. M. de Morgan, Director-General of the Antiquities Department, is engaged upon repairing the great hall of columns at Karnak."

At the Royal Artillery Institution, Woolwich, on Thursday last, Dr. G. H. Bryan, F.R.S., lectured on "Flight and Flying Machines." The lecturer pointed out that the power of flying had been developed under more favourable conditions in small than in large animals, both because the risk to life and limb in the case of a fall increased with the size of the animal, and also because, assuming De Lucy's law, large bodies required more power to sustain every pound of their weight in horizontal flight than small ones. These considerations applied equally to flying machines. As Lord Kelvin had said, Maxim's experiments had solved three of the five problems connected with artificial flight, and the two remaining ones were now solved by the soaring experiments of Lilienthal in Germany, and Pilcher in Britain. All that remained was to combine the advantages of Maxim's and Lilienthal's apparatus in a single machine, and in this Dr. Bryan prophesied that artificial flight would be accomplished at no distant date.

At King's College, on Tuesday next, in continuation of the free lectures given to the public, in the theatre of the College, Prof. Bottomley will discourse on the "Romance of Plant Life."

At a meeting of the Royal Geographical Society, to be held to-morrow afternoon, a plan for the geographical description of the British Islands on the basis of the Ordnance Survey will be submitted by Dr. H. R. Mill, and a discussion will take place upon it.

The Council of the Society of Arts attended at Marlborough House on Wednesday, February 19, when H.R.H. the Prince of Wales, President of the Society, presented to Sir Lowthian Bell, Bart., F.R.S., the Albert Medal, "in recognition of the services he has rendered to arts, manufactures, and commerce

by his metallurgical researches and the resulting development of the iron and steel industries."

THE deaths are announced of Dr. G. Wagener, Professor of Anatomy in Warburg University; Dr. R. Benedikt, Professor of Technological and Analytical Chemistry in the Technische Hochschule at Vienna; Dr. Laennec, Director of the Nantes School of Medicine, and formerly Professor of Physiology; and Dr. Per Hedenius, Professor of Pathology, Hygiene, and History of Medicine in the University of Upsala; Dr. D. D. Slade, Lecturer on Comparative Osteology in Harvard University, and known for his contributions to osteology, zoology and botany.

WE see from the *Rendiconti* of the Reale Istituto Lombardo, that, at the recent annual meeting, one of the Cagnola prizes of 2500 lire and a gold medal of 500 lire was awarded to Prof. Ferdinando Sordelli for his treatise entitled "Flora fossilis Insubriæ." The other Cagnola prizes were not awarded. Under the Brambilla bequest a sum of 300 lire and a gold medal was awarded to each of the following for having introduced useful industrial processes:—Messrs. Macchi and Izar, Augusto Stiegler, Anacleto Pastori, Fermo Coduri and Co., Casall Francesco and Sons, Carlo Galimberti and Co.; and 250 lire to Antonio Fusetti for his process of photo-engraving on copper. The Fossabi prize of 1000 lire for a work on arterio-sclerosis was awarded to a work sent in under the motto, *Experientia docet*. The Ciani prize for the best Italian historical reading-book was distributed among the following, who were awarded 500 lire each:—Prof. Francesco Bertolini, "Story of the Italian Revival"; Prof. G. De Castro, "The Mantua Processes and the 6th of February, 1853"; Prof. Pietro Orsi, "How Italy was made." Among the prizes proposed for 1897 are the following:—An Institute's prize of 1200 lire for an experimental proof that an electrified dielectric is in a state of tension in the direction of the field and in a state of compression across it (last date, April 30, 1897). Cagnola prizes of 2500 lire each for works on the orographical conditions of the Alps and the Italian peninsula and islands; and the history of the methods and instruments for registering the phase of alternating currents (both April 30, 1896). Similar prizes for works on the comparative anatomy of the innervation of trophic organs, and on the *rôle* of pathogenic microbes in human pathology (April 30, 1897). Secco-Commeno prize of 864 lire for a work on the genesis, symptoms, effects, and cure of uremia (May 1, 1897). The Tommasoni prize of 500 lire will be given for the best work on the life and work of Leonardo da Vinci, with especial reference to his precepts on the experimental method, and to a project of a national publication of his entire works (May 1, 1896). The competitions enumerated are open to all nationalities, and the memoirs may be written in Italian, French, or Latin. The last-named may also be written in English or German. They must be sent to the Secretary of the Institute, at the Palazzo di Brera, Milan, before the dates named, under a motto or pseudonym, and a statement of the prize competed for.

In reference to the tenacity of life in insects, Mr. J. C. Warburg writes to the *Entomologist*. "When I was still new to collecting in South France, I discovered one day, to my great joy, a large female of *Saturnia pyri* hidden away in some bushes. The specimen was the first I had ever caught, and I decided, on account of its large body, to stuff it (a quite unnecessary operation; I have kept dozens since unstuffed). The moth was first apparently killed by being forced into a cyanide-bottle, where it was left about an hour. The abdomen was then emptied, and the cavity filled with cotton-wool soaked in a saturated solution of mercuric chloride. The insect, pinned and set, was discovered next day attempting to fly away from the setting-board."

THE effect of thunder, or the firing of cannon, on pheasants is very curious; either of these sounds start the cock birds crowing as if in defiance. Mr. G. T. Rope, writing to the *Zoologist*, says that at a place between five and six miles distant from the garrison town of Colchester, he has heard pheasants close to him echoing each report of the artillery practising there, and has on many occasions noticed the same thing elsewhere. The crowing sounds more like the answer to a challenge than the expression of fear. Mr. J. E. Harting points out that the observation is not new. Gilbert White remarked a century ago that the pheasants in his neighbourhood crowed when big guns were fired at Portsmouth, and the wind was blowing from that direction; and, says Mr. Harting, Charles Waterton also, in his "Essays on Natural History" (first series, 1837), makes the following remarks on the subject:—"The pheasant crows at all seasons on retiring to roost. It repeats this call often during the night, and again at early dawn; and frequently in the day-time, on the appearance of an enemy, or at the report of a gun, or during a thunder-storm."

OUR American correspondent writes under date February 21:—"J. Frank Elline, of Baltimore, has demonstrated that ordinary calcium light will produce results similar to the rays from a Crookes' tube. By combining the calcium light with side X-rays, Mr Elline obtained a result directly the reverse of ordinary X-ray pictures, the shadows being darker than the background. Dr. Wellington Adams and Prof. Nipher, of Washington University, St. Louis, have demonstrated that the X-rays can be focussed. Edison is experimenting in the direction of taking pictures by snap-shots, and has already succeeded in reducing the time of exposure to seven seconds, getting clearly-defined images of strips of metal after the rays had penetrated a heavy piece of cardboard and a vulcanised plate. Trowbridge claims to have secured instantaneous results already. Edison reports that his eyes were sore after working for several hours with his fluorescent tubes; but he is not certain that this result is specially attributable to the X-rays. Dr. Wm. J. Morton reports that he sees brilliant flashes of light after he has discontinued work, and, as he has worked with electrical light for many years without injury, he infers that the X-rays are injurious to the eye.

WITH reference to the statement in the foregoing note, as to the effect of Röntgen rays upon the eyes, Mr. Swinton informs us that though Mr. J. C. M. Stanton and himself have worked continuously with the Crookes' tubes for hours together, neither of them has experienced any ill-effects so far as their sight is concerned. In fact, so far as Mr. Swinton has observed, the X-rays do not, *per se*, in any way affect the eye, either at the time of the experiment or afterwards. With regard to Mr. Edison's experiments, a few seconds are found to be ample for taking pictures of pieces of metal. When it is a question of photographing a portion of the body, however, it is a different matter; but even then, with a good tube, thirty or forty seconds' exposure will give a very fair result.

DR. W. J. VAN BEBBER, of the Deutsche Seewarte, has sent us a separate copy of an interesting paper "On the climates of the earth and their influence on mankind," published in *Globus* (vol. lxix. Nos. 6 and 7). After giving a general description of continental and ocean climates, and of the influence of mountains and forests, he discusses in some detail the peculiarities of climate of various zones, and traces their influence on diseases, especially on malarial fever and cholera in the tropics. He finds that the occurrence of the former is closely related to rainfall and temperature; the fevers begin with the rainy reason, usually reach their maximum by the time the rain abates, and decrease as cooler

weather sets in. The malady becomes acute when warm weather occurs after an inundation. During the present century there have been five great epidemics of cholera. In the origin and development of this disease the weather conditions are found to have different effects, according to the locality. In Bombay and Calcutta, for instance, it generally begins before the hot and rainy season, and decreases with increasing temperature and rainfall; while in other parts, cholera is most frequent towards autumn, and decreases with decreasing temperature. The occurrence of land and sea breezes (including monsoons) in various parts of the globe is discussed at some length.

THE relations of the weather to the spread of disease are still involved in obscurity. Prof. Cleveland Abbe defends the general atmosphere from calumny in this connection in the *Monthly Weather Review* (vol. xxiii. No. 8, 1895). History records that, in the fifteenth century, a plague epidemic broke out most violently in a Swiss town immediately after a cloud, coming from an infected but distant region, discharged its rain upon that town. But, as Prof. Abbe points out, without going back to the fifteenth century, there was an excellent opportunity to investigate the subject in 1889-90, when the influenza spread over the whole civilised word. Its progress was so regular that for a long time there was a general belief that the active germs of influenza were carried as dust in the air by the winds, or perhaps by the upper currents. This idea was dissipated by several memoirs that established the fact that the wind and weather were entirely subordinate factors, and that the spread of the disease followed the lines of travel, especially the principal steamboat and railroad routes, and that, therefore, the germs were carried by diseased individuals, or by articles that had been used by or had come in contact with them, and not by the winds. Of course the wind, in the narrow sense, may have carried the germs a few feet or rods from one individual to another, but not for distances of many miles. Several epidemics, such as the yellow fever, small-pox, and cholera, have been traced back to the direct importation of their contagia (whether animate or inanimate) by human agencies. Furthermore, experimental data show that few disease germs can maintain their vitality more than a few hours when freely exposed to the air and sunshine, as would probably be the case if they were carried in the atmosphere as minute particles of dust. Therefore Prof. Abbe thinks it probable that the winds and the rain must not be considered as the means by which diseases are spread between places that are any considerable distance apart.

PROF. SERGI (*Centralblatt f. Anth. Eth.*, &c.) complains that the Indo-Germanic theory of the origin of European peoples has distracted attention from the Mediterranean peoples. For some time past these latter have been studied by him, of whom he recognises four main branches—Lybian, Iberian, Ligurian, and Pelasgian. The Egyptian monuments state that the ancient Egyptians came from the land of "Punt," and anthropologists admit an African origin for that people. Sergi places Punt in Ethiopia, Somali-land, and part of South Arabia, and he finds the same head-forms amongst the ancient Egyptians and modern Somalis. This stock is known under the term "Hamitic," and it differs from the Semitic. Remains of prehistoric men from Spain, France, North Italy, &c., show a close resemblance with each other and with the early inhabitants of North Africa and the Canary Islands. Sergi asserts that the same people form to-day the bulk of the living populations of Spain, Italy, and Greece. He believes that the Hamites arose in East Africa; the first migration entered Egypt, then the stream diverged to the east to Syria and Asia Minor, and spread westwards as far as the Canary Islands; the Iberians, Ligurians, and Pelasgians (with the Etruscans) being branches of the main stem. These Mediterranean folk occupied South Russia, Switzerland, France, and Great Britain. In Neolithic times they were exterminated in the valley of the Po and in Switzerland, were driven beyond the Loire in France, and to the south and west in Britain by the mighty Celts. He describes the physical features of this Mediterranean group as a whole, and declares it to be the most beautiful of all the varieties of man.

THE part of the *Agricultural Gazette of New South Wales* for December 1895, contains a number of papers on the cultivation of fruits, and other crops, and on the diseases which affect cultivated plants in the colony, showing the valuable results obtained by the establishment of a State Department of Agriculture.

IN the *Irish Naturalist* for February is a useful paper by one of the editors, Mr. R. L. Praeger, on the botanical subdivision of Ireland, in which the island is parcelled out into forty districts. The geographical county boundaries are to a large extent preserved, and all the larger counties cut up into several divisions. The paper is accompanied by a map.

FROM the Skandinavisk Antiquariat, Copenhagen, has come to us a catalogue of a good collection of ancient and modern works on geography, ethnography, and travels, together with a number of rare maps and prints, offered for sale. A number of treasures to geographical bibliophiles will be found included in the catalogue.

THE 1896 *Annuaire* of the Observatoire Royal de Belgique has only just come to hand. As in former years (the publication has been issued without interruption since 1834), the contents are composed of ephemerides, containing the principal astronomical date for the current year; geographical, meteorological, and vital statistics; definitions of physical constants, and short articles, chiefly by M. Folie.

DR. G. EISEN reprints, from the *Proceedings* of the Californian Academy of Sciences, a paper entitled "Biological Studies of Figs, Caprifigs, and Caprification." He gives a history of the methods adopted from the earliest times for artificially pollinating the cultivated fig. While the ordinary edible figs grown both in Europe and in America, are independent of artificial pollination, the Smyrna fig will not mature without caprification, since the fig contains no male, but only female flowers.

WE have received a copy of a "Classificatory Chart of the Commoner British Orders of Flowering Plants," by Mr. W. P. Winter. That can hardly be regarded as an ideal selection of the more important orders, which excludes the Solanaceæ, Euphorbiaceæ, and Coniferæ, and admits the Chenopodiaceæ, Alismaceæ, and Naiadeæ. But this is explained by the footnote that "the orders include those necessary for the Elementary Examination, South Kensington." The characters seem carefully drawn up, and the chart will be a useful one to students.

THE development of photography, brought about by the discovery of Röntgen, has afforded the photographic journals excellent opportunities for distinguishing themselves. The special issue of the *Photogram*, brought out under the title of "The New Light," has run into a fifth edition; and the *Photographic Review* for March, apparently aims at obtaining the same measure of success, for its pages are almost entirely devoted to accounts and illustrations of work done by Mr. A. A. C. Swinton and Dr. Hall Edwards with Röntgen rays.

WE again offer our congratulations to the Wellington College Natural History Society. The twenty-sixth annual report of the Society shows that during 1895 the knowledge of the members was improved by means of lectures, and the faculties of a few ardent observers were developed. The Pender prize, founded in 1879, for the best essay on some scientific subject,

written by a member or associate of the Society, was won last year by Mr. H. C. Hayward, with an essay on "Protective Resemblances amongst English Lepidoptera." In awarding the prize, preference is given to essays containing original work.

THE London Amateur Scientific Society held its annual meeting on Friday last, at the Memorial Hall, Farringdon Street. Among the very interesting exhibits were a series of curious botanical specimens shown by Mr. Howell, a collection of rare and abnormal forms of Mollusca, by Mr. S. Pace, and an album of views of the Baku Oil Region, by Dr. W. F. Hume. After the specimens had been described, a paper was read by the President (Mr. W. H. Davis), on the "History of the Determination of Latitude and Longitude." Mr. Davis reviewed the existing state of geographical knowledge from the Homerian period to the time of Strabo and Ptolemy—its eclipse in the Middle Ages, and revival under Arabic influence, and progress up to recent times. He pointed out the method adopted in each successive epoch to determine positions on the earth's surface, and the progressive influences on scientific research induced by these inquiries. The objects of the Society is to further the study of the natural sciences among amateurs and students by the reading of papers, by excursions, lectures, the formation of a library, and in other ways. A Society having for its aim the cultivation of interest in natural knowledge, deserves encouragement and success.

SEVERAL publications have been received from the Meteorological Observatory of the Imperial University of Odessa. The *Annales* for 1894 contain a description of the Observatory; observations made during the year; and an account of the mortality and characteristic elements of the climate of Odessa. In the *Revue Météorologique* (vol. vii.) the meteorological observations made at stations in the south-west of Russia are brought together. The numerous observations at the stations organised in that region by Prof. A. Klossovsky, who is responsible for the whole of the publications, have enabled him to study the question of torrential rains during the period 1886–92, which discussion forms the subject of a separate paper.

THE elaborate "Leçons sur l'Electricité et le Magnétisme," by MM. E. Mascart and J. Joubert, has reached a second edition, the first volume of which, dealing with "Phénomènes Généraux et Théorie," has been received from MM. Masson and Co. Prof. Mascart is alone responsible for the new edition, Prof. Joubert being unable to assist in bringing the work into line with the present state of electrical knowledge. The many modifications introduced into the text, and the additions rendered necessary by the development of the science of electricity, has not resulted in any alteration of the general plan of the work. The second volume will be published at the end of this year, and will be devoted to the study of methods of observation, details of experiments, and the examination of the principal characteristics of industrial applications of electricity.

THE Field Columbian Museum at Chicago, a description of which was given in NATURE of June 6, 1895 (vol. lii. p. 137), commenced last year a series of publications having for its object the description of the contents of the Museum, and the issue of papers which come within the range of scientific or technical discussion. The publications will thus include not only catalogues of collections, but also transactions, memoirs, bulletins, monographs, and handbooks. There will be separate series for botany, zoology, anthropology, geology, and history, and each series is to have a separate pagination and volumes, so that the literature of each science or general subject will be rendered consecutive and complete for binding. No time is being lost in making known the extent of the collections in the different departments of the Museum, and Publications 2 and 3, which have just reached us, show that a high standard is aimed at. In one of these publications (Hist. Series, vol. i. No. 2), Mr. W. E. Curtis describes "The Authentic Letters of Columbus." The original Columbus documents which form the subject of his valuable bulletin were exhibited at the World's Columbian Exposition. Photographs were taken of the entire collection, and the negatives were subsequently presented to the Field Columbian Museum. The facsimiles thus obtained, now form part of the material in the Department of Columbus Memorial of that institution, and from them excellent half-tone plates have been made to illustrate Mr. Curtis's bulletin, which contains translations of all the manuscripts of Columbus existing, arranged in the order of the dates at which they are supposed to have been written; it will, therefore, be of extreme interest and service to students of geographical history. The second publication which we have received (Geol. Series, vol. i. No. 1), is a "Handbook and Catalogue of the Collection of Meteorites," by Dr. O. C. Farrington. Constructed on much the same lines as Mr. Fletcher's "Introduction to the Study of Meteorites," the publication will prove helpful to all who are interested in "holy things fallen from heaven." From the historical portion of the work a knowledge of the principal characters of meteorites will be obtained, while the catalogue of specimens in the Museum will facilitate the study of the collection. Maskelyne's classification of meteorites into aërosiderites, aërosiderolites, and aërolites, is followed in the catalogue. Six plates, each containing several figures illustrating the forms of meteorites, Widmanstätten figures, and microscopic structure, accompany Dr. Farrington's descriptions.

SOME speculations of considerable interest are put forward by M. Guntz in the current number of the *Comptes rendus*. Recalling the observations of Prof. Ramsay on the reduction of the vapour pressure of mercury by dissolved metals, from which the conclusion was drawn, that, at the boiling-point of mercury, the molecular weight of the metal in solution was in general equal to its atomic weight, M. Guntz puts forward the idea that in the case of metals extracted from their amalgams at a low temperature, the residue actually consists, for the most part, of the element in the atomic state. This, and not merely the fine state of division, he regards as the explanation of the energetic properties exhibited by such metallic residues. In support of this, thermo-chemical data are given for ordinary fused manganese, and manganese from its amalgam, the heats of combination with oxygen showing that the conversion of the latter into the former is accompanied with the evolution of heat (3·8 calories for the gram-atom). Besides manganese, both chromium and molybdenum, which after being fused are unchanged in air, are pyrophoric when extracted from their amalgams at low temperatures. M. Guntz proposes to study the heats of polymerisation of several metals, more especially of iron.

PROF. ARCIMIS informs us that the bearings he gave to the diagram (Fig. 1), which accompanied his description of the Madrid meteor (*ante* p. 395), were wrong. The south point should have been at the top of the diagram, and the east to the right.

THE additions to the Zoological Society's Gardens during the past week include three Punjaub Wild Sheep (*Ovis vignei*, ♂ ♀ ♀), from North-West India, presented by Captain R. A. Ogilby; a Vulpine Phalanger (*Phalangista vulpina*, ♂) from Australia, presented by Messrs. Multon and Wallis; a Fraser's Eagle Owl (*Bubo pœnsis*) from Ashanti, presented by Major H. M. Sinclair, R.E.; a Greater-spotted Woodpecker (*Dendrocopus major*), British, presented by Mr. W. H. St. Quintin; two Spiny-tailed Mastigures (*Uromastix acanthinurus*) from Biskra, Algeria, presented by the Lord Lilford; a Collar-

further established fifty scholarships tenable at the Company's school at Woodford in Essex, a first grade modern school, and offered them for competition by boys attending metropolitan public elementary schools. They co-operated in the conversion of one of their charities, now known as the Sir Wm. Bowman's Foundation, Greenwich, by means of which one hundred boys, selected by competition from public elementary schools in Greenwich, are now receiving gratuitously education in the Upper School of Greenwich Hospital. They have established scholarships in connection with the People's Palace Technical Day School, and some two hundred boys from metropolitan public elementary schools are now receiving gratuitous education there of a character to fit them to take their place as apprentices and improvers in workshops and manufactories. These scholarships are also offered for public competition.

In the year 1888 the Company, recognising the value of manual training as an adjunct to the general education of boys and girls, voted £1000 towards the cost of introducing and carrying on such training in metropolitan elementary schools for one year. The grant has annually been renewed since that date, and the manual classes are largely maintained by means of this grant. To places of higher education, both in London and the provinces, the Company have for many years past, and are still voting assistance. They established the spinning department of the Belfast Technical School; the engineering department of the University College of South Wales, Cardiff; the coal-mining department of the Yorkshire College of Science, Leeds; and they were the principal contributors to the establishment of the department of technical education in the University College of Nottingham. They have also made large grants for buildings and apparatus to many other educational institutions. During the year 1892, they expended no less than £26,000 in the promotion of education.

Since 1893, the Drapers' Company have very largely extended the educational work of the People's Palace; in fact, they have contributed about £100,000 to that institution. They have also increased their grants to the various provincial institutions mentioned in the foregoing, and assisted several others. Their School Board scholarships have been annually renewed, and they are maintaining their subscription of £1000 a year to the manual training classes in London elementary schools. About two years ago they established six scholarships with the view to enabling certain selected pupil-teachers from elementary schools to proceed to one of the universities. This scheme is working successfully, and will no doubt be developed. At present the Company are subscribing £400 to £500 per annum for these scholarships. They are also contributing a somewhat similar amount for the apprenticeship of boys to handicraft trades. The foregoing refers to work done by the Company in its corporate capacity. As trustees, they administer several important educational and apprenticeship endowments, and for the most part free of all expense to the charity.

The Fishmongers' Company have contributed a total sum of £68,760 to the City and Guilds Institute, £525 to the Borough Road Polytechnic, £340 to the North London Polytechnic, £52 10*s*. to the Wandsworth Technical Institute, £210 to the Baltimore Fishery School, £4300 to the Marine Biological Association, Plymouth, and £105 to the British Institute of Preventive Medicine. They also grant a scholarship of £60 to a student of the Finsbury Technical College, to be held at the City and Guilds Institute. The Company also grant eighteen exhibitions of £40 each to students of the Universities, and four exhibitions of £20 each to Masters of Arts, four scholarships of £50 each to the City of London School, and four of £50 each to the Central Foundation Schools, besides the large sums expended in the inspection of fish and the protection of salmon.

The Goldsmiths' Company, unlike some of the other great Companies, have no educational trust; but they spend a large proportion of their corporate funds upon technical, scientific, and general education. The Company was one of the first of the Companies to take up the subject of technical education, and they have been connected with the City and Guilds of London Institute from its inception; and to this Institute the Company have been the largest donors, their contributions to the present date exceeding £80,000, in addition to which they give an annual subscription of £4000. The Company have also, at their sole cost, established and endowed their Technical and Recreative Institute at New Cross. The capital expenditure upon the site, buildings, and equipment of this Institution amounts at this date to very little less than £100,000; and the Company have also assigned to it a minimum endowment of £6000 per annum. As regards general education, the Company have established seventy exhibitions of £50 per annum each for poor students at Oxford and Cambridge. These exhibitions are awarded solely for merit, coupled with a careful consideration of the pecuniary needs of the candidates. The Company also contribute to Newnham and Girton Colleges for poor lady students; and they make considerable occasional grants to other educational Institutions. A short time ago the Company granted £1000 to the Royal Institution, for the furtherance of Prof. Dewar's researches at low temperatures; and £1000 to the Imperial Institute, for research work in connection with Indian and Colonial products; and they have also recently given £1000 for the prosecution of research work in connection with the anti-toxin treatment of diphtheria. Altogether, a careful examination of the Company's expenditure during the past ten years shows that during that period thirty per cent. of the *gross* corporate income of the Company has, on an average, been devoted to educational purposes, and, as above mentioned, all this expenditure is made out of the Company's private funds.

The Skinners' Company give £2000 per annum to the City and Guilds Institute and contribute towards the support of the Northampton Institute at Clerkenwell—the chief of the three members of the City group of Polytechnics. Many other grants have been made from time to time for educational and other purposes, scientific and recreative.

The Merchant Taylors' Company expend out of their corporate income between £7000 and £8000 a year on their school at Charterhouse Square, grant £2000 a year to the City and Guilds of London Institute, and make other grants of considerable sums for educational purposes, the total annual average expenditure on general education amounting to 28 per cent. of the net corporate income.

The Haberdashers' Company's donations and grants are, we are informed, mainly devoted to general education; but no specific information has been furnished us with reference to them.

The Salters' Company have founded the following scholarships and Fellowships for the promotion of science, viz.:—£100 per annum to the Pharmaceutical Society of Great Britain for higher scientific research. £100 per annum to St. Thomas's Hospital for a like object. £150 per annum to the City and Guilds Institute for research in chemistry in its relation to manufactures (towards the general objects of which Institute the Company also subscribe nearly 1000 guineas per annum). The Company have founded Natural Science Exhibitions in connection with the City of London School and King's College School, London, which exhibitions are of the annual value of £80 each, as well as scholarships of lesser value at the Guildhall School of Music and the Royal Naval School, and, although perhaps not of a scientific nature, scholarships have been founded in connection with the Philological School in Marylebone Road, and Trent College, Nottingham. In addition to the above, the Company contribute to many objects of acknowledged public utility, the amount of which contributions, in 1894, was some £5000.

The Clothworkers' Company have very generously contributed towards the advance of technical education in London and the provinces, as will be seen from the subjoined statement of grants. The Company have also established a research laboratory in connection with the Clothworkers' Textile, Dyeing, and Design Departments of the Yorkshire College, Leeds. Numerous papers descriptive of work done in this laboratory have been contributed to the Chemical Society and the Society of Chemical Industry. The Company's grants to scientific institutions in London are:—City and Guilds of London Institute (£3500 per annum), £68,250; Imperial Institute, £2500; King's College (Scholarships not exceeding £225 per annum), £2000; King's College (Kensington Branch for the Higher Education of Women), £500; University College (Scholarships, £60 per annum), £650; Northern (Islington) Polytechnic, £17,500; People's Palace Polytechnic, £1000; Borough Road Polytechnic, £1000; Regent Street Polytechnic, £500; South-Western Polytechnic, £100; Finsbury Polytechnic, £100; North-West London Polytechnic, £50; City of London College, £600; Birkbeck Institution, £205; Marine Biological Association, £500; British Institute of Preventive Medicine, £100; London Society for

Extension of University Teaching, £1100; Middle-Class Schools Corporation (now Central Foundation Schools of London), £2500; National Association for Promotion of Technical Education, £150; Bedford College (Physical and Chemical Laboratories), £125; Toynbee Hall, Whitechapel, £125; Society of Arts, £504; Royal Architectural Museum and School of Art, £142; Bethnal Green Free Library, £141; Recreative Evening Schools Association, £340; Froebel Educational Institute, £100; Parmiter Foundation School, £100; University Settlement, Bermondsey, £25; Palæontographical Society, £21; Onslow College of Science, £250—making a total of £101,178. To scientific institutions in the provinces the grants for building equipment and general purposes amount to:—Yorkshire College, Leeds (textile industries, dyeing, and art departments, wholly founded and maintained by the Company), £34,000; Bradford Technical College, £4350; Huddersfield Technical School, £2000; Halifax Technical School, £2100; Keighley Technical School, £1300; Dewsbury Technical School, £825; Salt Science and Art Technical School, Shipley, £825; Bingley Technical School, £350; Batley Technical School, £250; Holmfirth Technical School, £250; Ossett Technical School, £200; Wakefield Technical School, £100. In addition to this, the Company grant to these institutions annually for maintenance a sum amounting to about £4000.

It is interesting to compare with the grants named in the foregoing, the estimate which the Technical Education Board of the London County Council have just submitted to the Finance Committee of the Council, as to the sum required by them for the year ending March 31, 1897. The net probable expenditure will amount to £120,000, of which £9000 is for the equipment and £16,000 the maintenance of technical departments of polytechnics. The other items are £9680 for Shoreditch, Wandsworth, and other technical schools, £20,000 for technical departments of public secondary day schools (including allowance for the fees of the Board's county scholars £70,500), £4000 for higher education, £26,070 for county scholarships, £14,440 for art teaching (including art scholarships), £8985 for science teaching (including science exhibitions and pioneer lectures, technology, and manual instruction), £4200 for domestic economy, £1500 for commercial subjects, £1000 for museums, and £5550 for expenses of administration (including cost of inspection). In 1893-94 the Board's expenditure was £46,000, in 1894-95 £63,000, and in 1895-96 £91,000. The chief causes of the increase are assigned to the development of the board's scholarship system, which has nearly reached its limit, and is costing nearly £40,000 per annum; the increase in the amount of evening educational work carried on in accordance with the Board's regulations, and therefore eligible for the Board's grants; the very great increase in the number of students who are studying science practically, as shown by the recent report of the Board's science inspector, and the consequent expenditure incurred in equipping and maintaining laboratories; the opening of new polytechnics, and the development of the technical departments of other polytechnics, and the establishment of new institutions.

In one respect the Livery Companies are in advance of the Technical Education Board, and that is in the encouragement given to research. The funds of the Technical Education Board are used to create and foster classes and institutions concerned with technical instruction, and probably the Board does not feel at liberty to give any direct assistance to research in the way that some of the Companies are doing. But, at the same time, the Board is doing work which should eventually result in an increase in the ranks of investigators, and it is to be hoped that the time is not far distant when the polytechnics will make those contributions to knowledge which are the only sure indications of scientific advancement.

ZOOLOGICAL NOMENCLATURE.

At the meeting of the Zoological Society on Tuesday, Mr. P. L. Sclater, F.R.S., introduced a discussion on the following rules for the scientific naming of animals, compiled by the German Zoological Society.

A. General Rules.

(1) Zoological nomenclature includes extinct as well as recent animals, but has no relation to botanical names.

(2) Only such scientific names can be accepted as are published in print, in connection with a clear description either by words or figures.

(3) Scientific names must be in Latin.

(4) Names of the same origin and only differing from each other in the way they are written are to be considered identical.

(5) Alterations in names otherwise valid are only permitted in accordance with the requirements of Sections 13 and 22, and further for the purpose of purely orthographical correction when the word is without doubt wrongly written or incorrectly transcribed. Such alterations do not affect the authorship of the name.

(6) Of the various permissible names for the same conception only the one first published is valid (Law of Priority).

(7) The application of the Law of Priority begins with the tenth edition of Linnæus's "Systema Naturæ" (1758).

(8) When by subsequent authors a systematic conception is extended or reduced, the original name is nevertheless to be regarded as permissible.

(9) The author of a scientific name is he who has first proposed it in a permissible form. If the author's name is not known, the title of the publication must take its place.

(10) If the name of the author is given it should follow the scientific name without intervening sign. In all cases in which a second author's name is used a comma should be placed before it.

(11) Class (*classis*), Order (*ordo*), Family (*familia*), Genus (*genus*), and Species (*species*) are conceptions descending in rank one after the other, and are to be taken in the order here given. These terms should not be employed in a contrary or capricious relation or order.

B. Rules for Designating Species.

(12) Every species should be designated by one generic and one specific name (binary nomenclature).

(13) The specific name, which should be treated always as one word, should depend grammatically upon the generic name.

(14) The same specific name can only be used once in the same genus.

(15) In the case of a species being subdivided, the original name is to be retained for the species which contains the form originally described. In doubtful cases the decision of the author who makes the separation shall be followed.

(16) When various names are proposed for the same species nearly at the same date, so that the priority cannot be ascertained, the decision of the first author that points out the synonym should be followed.

(17) In the case of species with a cycle of generation of different forms, the specific term must be taken from an adult form capable of reproduction. In these cases, as also in species in which polymorphy occurs, the Law of Priority must be observed.

(18) The author of the specific name is the author of the species.

(19) The author's name should be placed in brackets when the original generic name is replaced by another.

(20) Hybrids should be designated either by a horizontal cross between the parents' names, or by these names being placed one above the other with a line between. The parents' sexes should be stated, when known. The name of the describer of the hybrid should be added, preceded by a comma.

C. Rules for the Names of Subspecies and other Divergences from Typical Species or Subspecies.

(21) When constant local forms, varieties, strains, &c., require special names, these names should be placed after the specific name. The rules for such names are the same as those for specific names.

D. Rules for Generic Names.

(22) Names of genera should be substantives, and of the singular number. They should be one word and be written with a large initial letter. If a subgenus is used, its name (which follows the same rules as a generic name) should be given in brackets after the generic name.

(23) A generic name is only valid when a known or a sufficiently characterised species (or several species) is referred to it, or when a sufficient diagnosis of it is given.

(24) The same generic name can only be employed once in

zoology. Nor can names already proposed as subgeneric be employed also as generic names in another sense.

(25) When several generic names are proposed for a genus at nearly the same date, so that their priority cannot be settled, the name for which a type-species is given is to be preferred. In all uncertain cases the decision of the author who first arranges the synonymy is to be followed.

(26) When a genus is separated into several genera the old name must be retained for the type-species. If this cannot be positively ascertained, the author who splits up the genus must select one of the species originally in the genus as the type. When a subgenus is raised to generic rank the subgeneric name becomes the generic name.

E. Rules for the Names of the Higher Systematic Groups.

(27) Names for higher systematic groups of animals must have a plural termination.

(28) Names of families and subfamilies must henceforth be taken from the name of one of the genera belonging to the group, and formed from the stem of that name, with the addition of *-idæ* (plural of *-ides* [Gr. -ειδης], masc.) for the families and *-inæ* (fem.) for the subfamilies.

Mr. Sclater pointed out the principal points in which these rules conflict with the Stricklandian Code commonly used in this country. These were three in number, namely :—

(1) The German Rules (Sect. 1) disclaimed any relation to botany, so that, according to them, the same generic names might be used in zoology and botany. This was contrary to the Stricklandian Code (Sect. 10).

(2) Under Sect. 5 of the German Rules the same term was to be used for the generic and specific name of a species, if these names had priority. This was contrary to the Stricklandian Code (Sect. 13).

(3) The German Rules (Sect. 7) adopted the tenth edition of the "Systema Naturæ" (1758) as the starting-point of zoological nomenclature, whereas the Stricklandian Code (Sect. 2) adopted the twelfth (1766).

After a few remarks from the President (Sir W. H. Flower), Mr. Hartert spoke in favour of the modifications proposed in the German Rules. The debate was continued by Prof. Lankester, Mr. H. J. Elwes, Dr. D. Sharp, Mr. Blanford, Dr. H. O. Forbes, and others, but no final resolution was adopted.

SCIENCE IN THE MAGAZINES.

The eleventh instalment of Mr. Herbert Spencer's admirable series of papers on "Professional Institutions" appears in the *Contemporary*, the profession of which he traces the development this month being that of the painter. Mr. Spencer does not concern himself with the rude drawings made by prehistoric man, but deals rather with the development of pictorial art from the point at which the early civilised stage is connected with the uncivilised, illustrating his arguments by reference to the remains and records of historic peoples. The first step in the development appears to have been the painting of the image of a dead man, to be placed on his grave. Priests painted as well as carved these effigies ; in fact, an examination of available evidence shows that "pictorial art in its first stages was occupied with sacred subjects, and the priest, when not himself the executant, was the director of the executants." Painting was originally subordinated to sculpture, which fact accounts for its relatively slow development. It became secularised in the later stages of Grecian life. Mr. Spencer traces these changes, as well as the differentiation of the lay painter from the clerical painter, and the differentiation of lay painters from one another.

Short descriptions of the chief discoveries of Edison and Tesla are given in *Scribner*, by Mr. E. B. Andrews, in the course of his "History of the Last Quarter-Century in the United States," his article being a continuation of previous ones contributed by him to the same magazine. "Edison," he remarks, "is famous less for originality than for dogged patience and subtle insight, enabling him to fructify others' devices. . . . A more original genius than Edison, veritably a wizard, is his young disciple, Nikola Tesla, who was born in Servia, and found employment with Edison on landing in America." *Scribner* also contains an illustrated article on "Carnations," by J. H. Connelly.

Under the title "Ways and Means in Arid America," Mr. W. E. Smythe contributes to the *Century* an account of the influence irrigation has exerted upon the development of Kansas and her sister States during the past fifteen years. The adoption of irrigation in a territory which had hitherto depended entirely upon the rainfall "extended the known limits of arid America hundreds of miles to the eastward [of Garden City] and more than one thousand miles north and south, thus adding to the empire of irrigation all the western portions of the Dakatos, Nebraska, Kansas, Oklahoma, and Texas, together with eastern Colorado." Mr. Smythe's description of what has been achieved during the past few years in these States, and in several widely separated localities in America, is a valuable object-lesson for farmers and fruit-growers.

The following are among other articles of scientific interest in the reviews and magazines received :—"The Increase of Insanity," by Mr. W. J. Corbet, in the *Fortnightly*, and an article in the *Humanitarian*, on "The Multiplication of the Unfit," by Mr. Arnold White, having much the same teachings ; "The Baltic Canal, and how it came to be made," by Mr. W. H. Wheeler, in *Longman's* ; "The Development of Dodos," in the *National*, in which Miss Mary Kingsley shows some of the effects of European culture on the West African, her paper supporting the views expressed at the British Association meeting last year, when a formal discussion took place on the results of interference with the civilisation of native races ; "The Tintometer," and "An Old Geography," in *Chambers's Journal* ; "Niagara Falls and Water Power," by Mr. Alex. Richardson, in *Good Words*.

SMITHSONIAN INVESTIGATIONS.

Mr. S. P. Langley's report of the operations of the Smithsonian Institution during the year ending with June 1895, has come to hand. The report includes a general account of the affairs of the Institution during the period it covers, and also descriptions of the work accomplished in the U.S. National Museum, the Bureau of Ethnology, the Bureau of International Exchanges, the National Zoological Park, and the Astro-physical Observatory. We extract from it the following brief statement with reference to three investigations carried on under the supervision of the Institution :—

The investigation of the infra-red spectrum has been continued in the Astro-physical Observatory during the past year with increased energy, and Mr. Langley says that though only provisional results have yet been published, which are intended merely to show the character and progress of the work, it is because the means of giving greater exactness are constantly growing, so that the result it is now hoped to present will be given with the aim of a still higher standard of precision ; an aim which it may be trusted will be considered a legitimate cause for the delay in the appearance of the final results.

It is stated that a larger number of bolographic records has been obtained than in any previous year, and that these continuous observations have been accompanied by further improvement in the apparatus, a higher standard of accuracy, and a nearer approach to the completion of the research ; but that they have also shown beyond a doubt that the limit of accuracy which is desirable can never be reached in the present most unsuitable, provisional site, which is subject to every kind of disturbance due to the neighbourhood of the streets of a busy city.

Prof. E. W. Morley's investigations on the density of oxygen and hydrogen, referred to in previous reports as aided in part by the Institution, have been completed, and his memoir has been published. The atomic weight of oxygen may be called the base upon which practically our entire system of atomic weights rests, and a small error in its measurement becomes large by multiplication in the higher parts of the atomic weight scale. Hence its accurate determination is of fundamental importance. In his investigation Prof. Morley has studied the problem by two methods : (1) By the synthesis of water, in which he, for the first time, has achieved completeness by actually weighing the hydrogen, the oxygen, and the water formed, whereas all his predecessors took one or another of these factors by difference. (2) By the density ratios between oxygen and hydrogen. In this method he has weighed the gases of greater purity and in larger quantity than hitherto, and he has in some instances operated without the intervention of stopcocks, and therefore with no possibility of error due to leakage. He has also, as a correction to the density ratio,

redetermined the composition of water by volume. By both methods he reaches the same result: O = 15·879, with variation in the fourth decimal place as between the two.

Dr. J. S. Billings and Dr. S. Weir Mitchell have completed the investigations begun by them in 1893, under a grant from the Hodgkins fund, to determine the nature of the peculiar substances of organic origin contained in the air expired by human beings.

In their report the investigators state that for a number of years prior to 1888 the prevailing view among physicians and sanitarians had been that the discomfort and dangers to health and life which had been known to exist, sometimes at least, in unventilated rooms occupied by a number of human beings were largely or entirely due to peculiar organic matters contained in air expired by these persons, and that the increase in carbonic acid due to respiration had but little effect in producing these results, its chief importance being that it furnished a convenient means of determining the amount of vitiation of the air. Recently, however, several experimenters have concluded that the organic matters in the exhaled breath are not harmful, at all events to animals, and the main object of the investigations was to determine the correctness of these conclusions.

The investigators found that the air in inhabited rooms, such as the hospital ward in which experiments were made, is contaminated from many sources besides the expired air of the occupants, and that the most important of these contaminations are in the form of minute particles or dust, in which there are micro-organisms, including some of the bacteria which produce inflammation and suppuration. It is probable that these dust particles were the only really dangerous elements in the air, and it appears improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals other than carbonic acid.

In concluding their report the authors state that the results of the investigations, taken in connection with the results of other researches summarised in the report, indicate that some of the theories upon which modern systems of ventilation are based are either without foundation or are doubtful, and that the problem of securing comfort and health in inhabited rooms requires the consideration of the best methods of preventing or disposing of dusts of various kinds, of properly regulating temperature and moisture, and of preventing the entrance of poisonous gases like carbonic oxide derived from heating and lighting apparatus, rather than upon simply diluting the air to a certain standard of proportion of carbonic acid present.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS HELEN M. GOULD has presented a scholarship of 7000 dols. to Wellesley College.

MRS. S. V. HARKNESS, of New York City, has given 50,000 dols. to the Women's College of the Western Reserve University at Cleveland, Ohio, to establish a chair of biblical literature.

MR. W. C. FLETCHER, master at Bedford Grammar School, has been appointed head master of the High School and Commercial School of Liverpool Institute.

A PARLIAMENTARY paper has just been issued containing a Treasury minute to the effect that the grant to King's College, London, which was suspended by the late Government owing to the retention of denominational tests by the college, shall be continued without any stipulation as regards tests. The college will therefore receive, as from April 1 next, an annual sum of £1700 during the remainder of the term of five years, for which period, beginning in 1894, the grant of £15,000 a year to university colleges in Great Britain was to be proposed to Parliament. The other colleges are also to be informed that the increase in their grants caused by the suspension of the grant to King's College will not be continued beyond the end of this month.

IT has been proposed in the Chamber of Deputies (says the Paris correspondent of the *British Medical Journal*) that from the unreclaimed sums of savings banks and other deposit sums to the amount of £10,000 should be paid to the different French laboratories, £2600 to the Pasteur Institute and to the laboratories of higher education in Paris, including the Val-de-Grâce Hospital laboratory and the Alfort School of Veterinary Medicine, for the purpose of aiding researches on contagious diseases, especially those in connection with serums and vaccines; £5000 to the medical school laboratories of Lyons, Bordeaux, Montpelier, Toulouse, Lille, and Nancy, likewise to the veterinary schools of Lyons and Toulouse; also for the purposes of experimental research for contagious maladies, including the further study of serums and vaccines; and £2400 to the therapeutical, pharmacological, and medical chemistry laboratories of the medical faculties and pharmaceutical schools to be devoted to the study of the methods of treating contagious diseases, likewise of the drugs. Every year reports of the work done at these establishments are to be sent to the Minister of Public Instruction. The Minister will afterwards send them either to the Academy of Sciences or Academy of Medicine.

THE views with reference to training in scientific method, which have been advocated with great persistence by Dr. H. E. Armstrong for some years, are beginning to bear fruit. Mr. A. B. Badger, in a scheme for technical education which he has drawn up for the Carnarvonshire County Council, devotes a section to pointing out the advantages of training in observing, experimenting, and reasoning by practice in the methods of science, and he urges the claims of such instruction to recognition. His remarks are so different from those of technical advisers and organising secretaries of most of the County Councils, that we are glad to quote them. "Throughout life we are largely engaged in exercising the faculties with a view to action. We ought, therefore, as early as possible, to be trained to see things as they are, to compare facts together, and to draw just conclusions; such training ought to form part of the fundamental education of all. The highest authorities are agreed that habits of observing accurately, experimenting exactly and reasoning logically, are best formed by practice in the methods of science. For years past science has been taught in schools, but far too often the pupils have only been lectured to and shown experiments, or if they have done practical work, it has been a kind which required the minimum of observation and deduction. Primarily, it is not knowledge of the facts of chemistry, or physics, or mechanics, which is wanted, but training in the methods by which these facts were discovered, thus developing the faculties by which, in every occupation of life, the facts necessary to it are ascertained, and their relative values determined." We trust that the suggestions contained in Mr. Badger's carefully-constructed scheme will be adopted by the Local Governors and Headmasters of the County Schools, who will consider them in conjunction with the Technical Education Committee of Carnarvonshire.

SOME of the tables which form the appendix to volume I. of the Report of the late Royal Commission on Secondary Education are of a most interesting and valuable nature. The first of these sets forth the amounts appropriated and spent during the financial year 1893-4 under the Local Taxation Act, 1890. We find the amount available for educational purposes in the counties was £595,838 16*s*. 6*d*., of which £448,130 17*s*. 1*d*. was actually appropriated by the County Councils for this object, though only £396,143 6*s*. 2*d*. was really spent. This sum was disposed of as follows:—Grants to secondary schools, £17,168 17*s*. 10*d*.; to scholarships and exhibitions, £40,047 19*s*. 6½*d*.; to evening continuation classes, £13,921 14*s*. 10*d*.; special classes for elementary teachers, £22,781 9*s*. 6*d*.; technical and art schools and classes, £191,011 13*s*. 5½*d*. Of the last-mentioned amount no less than £134,578 1*s*. 9½*d*. went to "classes" of one sort and another. The amount available for county boroughs was £152,224 7*s*. 4*d*., but owing to the accumulation of funds in the previous years the amount appropriated reaches £158,687 8*s*. In addition to this, the sum of £8,659 6*s*. 10*d*. was raised under the Technical Instruction Act. A consideration of the expenditure in the boroughs brings forcibly under our attention the part that the School Boards are allowed to take in the disposal of the funds, for we find £13,161 8*s*. was placed in their hands to be dealt with by them. Under the same headings as those used in speaking of county expenditure we find £9,190 17*s*. 1*d*. for secondary schools; £5,444 9*s*. 10*d*. for scholarships and exhibitions; £5,263 7*s*. 6*d*. for evening continuation classes; for technical and art schools and classes the amount reaches £102,147 7*s*. 6*d*. of which only £19,645 5*s*. is spent on more or less detached classes. While Preston devoted none of its share to the purposes of education, and Northampton, Reading, and Great Yarmouth only a part, Coventry, Hanley, Nottingham, Rochdale, Sheffield, and Worcester, not only appropriated the whole of the amounts allocated to them, but also levied rates under the Technical Instruction Act.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 1, 1896.—Absorption and emission of electric waves by resonance, by Max Planck. When a secondary circuit is excited by waves of a period equal to that of the circuit, resonance takes place. Three stages may be considered. In the first, the circuit absorbs energy from the external wave system until it has acquired a maximum of oscillation. The next stage is stationary, the circuit absorbing as much energy as is necessary to compensate for energy radiated and converted into heat. The third stage represents the dying out of the oscillation after the primary wave has ceased. Maxwell's equation enables us to calculate the distribution of energy during each of these stages.—Propagation of electric waves in water, by E. Cohn and P. Zeeman. The method used is an improvement on the apparatus previously employed, the parallel wires being taken through the trough of water and passing beyond it direct into the bolometer. The most important results are that for frequencies ranging from 27 to 97 millions no dispersion is observable, and that the index of refraction for such vibrations equals the square root of the dielectric constant.—On the alleged dissipation of positive electricity by light, by J. Elster and H. Geitel. The illumination of the anode in a vacuum leads apparently to a dissipation of an electric charge similar to that observed when a liquid alkali alloy is illuminated as a kathode. This is, however, due to the effect of the light on the platinum kathode or the interior of the tube after it has acquired a slight coating of alkali metal vapour. When this is obviated, no dissipation takes place.—Change of resistance of a contact by electric irradiation, by V. v. Lang. When a rod of carbon is lightly stood upon a block of carbon, a certain sensitive degree of contact may be found which abruptly diminishes in resistance when electric waves are produced in the neighbourhood, say by an influence machine or even an electrophorus. Any slight concussion tends to restore the original resistance. Similar results are obtained with zinc and aluminium, but the very least shock spoils the experiment in this case.—Longitudinal light, by G. Jaumann (see p. 374).—On the electric arc, by L. Arons. It is well known that an alternate current arc light is much more difficult to produce between metallic than between carbon electrodes. This may be due to the lower thermal conductivity of the carbon, which enables it to retain its heat while the current passes through wires, or to the volatile gases which are always given off by carbon, or to the oxidation of the metals during the passage of the current.

Symons's Monthly Meteorological Magazine, February.—The mild winter, by the editor. Figures are given to show that, though mild, there has been nothing very exceptional in the present winter, although it bears a great contrast to the severe frost of 1895. The temperature of December last in London was only about 1° above the average; the temperature of January 1896 was about 3° above the average, but it has been exceeded in eleven years out of the last thirty-six. In January 1884, the lowest air temperature was 32°·2, and the whole month was 3° warmer than January 1896.—The high monthly mean pressure in January. The mean for the month in Camden Square was 30·360 inches. This has only been exceeded twice since the Camden Square record began in 1858, viz. in January 1880, when the mean was 30·370 inches, and in February 1891, when it was 30·472 inches. A table is given showing the high monthly pressures of 30·360 inches or upwards in the vicinity of London since 1779. This value has only been reached or exceeded on nine occasions, and the mean of February 1891, above quoted, is the highest.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 16.—"Memoir on the Theory of the Partitions of Numbers." Part I. By Major P. A. MacMahon, R.A., F.R.S.

This memoir presented is a natural sequel to the memoirs of 1891, 1893, and 1894, published *in extenso* in the *Philosophical Transactions*. In fundamental idea it is graphical, resting, on the one hand, upon the method of the memoir on the "Compositions of Numbers," of 1893, and, on the other, upon Sylvester's graphical method, set forth in his "Constructive Theory of Partitions," of 1882, published in vol. v. of the *American Journal of Mathematics*.

The memoir is divided into four sections. In § 1 the author gives new notions concerning the partitions of ordinary unipartite numbers, and shows that the theory of the separations of a partition necessitates the consideration of the partitions of multipartite numbers. The two theories proceed in parallel paths. One-to-one correspondence can be established at any point.

In § 2 he is engaged with the graphical representation of unipartite partitions. The graph that, in the memoir of 1893, was employed to denote a principal composition of a bipartite number is shown to be the graph also of a unipartite partition.

A new theory of unipartite partitions is evolved with algebraical developments in correspondence.

In § 3 he investigates a similar correspondence between the compositions of tripartite numbers and certain regularised partitions of bipartite numbers.

The method is of general application, and indicates a one-to-one correspondence between the compositions of $m+1$-partite numbers and contain regularised partitions of m-partite numbers.

In § 4 he takes up the question of the graphical representation of completely regularised multipartite numbers. He follows Sylvester, proceeding from two to three dimensions. Whereas Sylvester employed nodes in a two-dimensional corner, the author employs nodes piled up in a three-dimensional corner. Sylvester obtains a two-fold correspondence from the permutations of his axes x, y. The author obtains a six-fold correspondence from the permutations of the three axes x, y, z. Even Sylvester's two-dimensional graphs permit of six interpretations when viewed from the three-dimensional standpoint.

Physical Society, February 28.—Prof. John Perry, Vice-President, in the chair.—Sir D. Salomons showed some experiments with incandescent lamps. A large electro-magnet is excited by means of a continuous current, while an alternating current is passed through an incandescent lamp. On bringing the lamp near the magnet the filament is set in vibration, which, if the lamp is brought sufficiently near the magnet, is sufficiently intense to break the filament. The number and position of the nodes formed in the vibrating filament are found to be independent of the natural period of the filament, but depend on the frequency of the alternating current. Prof. S. P. Thompson asked whether it was not found that the number of segments into which the filament divides, depended to some extent on the natural period of the filament. Prof. Ayrton said that the magnetic leakage was very large with the arrangement adopted, and he would like to know whether this method was a more sensitive one for mapping out the field than those ordinarily employed. In an instrument designed by Prof. Perry and himself, an alternating current was passed through a wire stretched between the poles of a magnet, and the tension of the wire was altered till the vibrations set up were a maximum. The natural period of the wire, and hence the frequency of the alternating current, was then deduced from the tension, &c. In Prof. Ewing's magnetic curve tracer, on the other hand, the natural period of the stretched wire was made as different as possible from the period of the alternations which were to be observed, so that the natural vibrations of the wire did not influence the results. The author's arrangement appeared to him (Prof. Ayrton) to be intermediate between these two, and it would seem that the natural period of the filament would to a certain extent influence the results. Prof. Perry suggested that the lamp might be held in a very steady support, so that after the large vibrations due to the natural period of the filament had died out, the vibrations of the period of the alternations alone could be observed. Sir D. Salomons, in his reply, said that the arrangement was not intended for making *measurements*. A lamp had been fixed in a steady clamp, and the current passed for many hours, but the character of the vibrations remained unaltered. He had found the vibrating filament useful for microscope work where a surface rather than a line of light was required.—Prof. Fleming read a paper by himself and Mr. Petavel, on an analytical study of the alternating current arc. The first part of the paper consisted of an analytical study of the distribution of light throughout the various radiating regions in the arc, when supplied with electric power of known constant amount, the periodic variations of the current through the arc and of the potential difference between the carbons being at the same time recorded. The power was measured by means of a bifilar watt-meter; while by means of a series of mirrors and a rotating disc carried by a synchronising alternate current motor, the mean value of the light taken from any part of the arc was compared with the instantaneous

value of the light taken from the same part of the arc, and taken at any assigned instant during the period. Thus the arc itself was its own standard, and difficulties due to slow variations in the mean light of the arc disappear. The facts observed may be summed up as follows:—The purple light of the true arc undergoes a periodic variation, and, as far as the eye can judge, is completely extinguished for a certain interval during the phase; it has equal maxima values during the period, at instants slightly lagging behind the instants of maximum power expenditure in the arc. On the other hand, the illuminating power of the carbon crater varies between a minimum value and two unequal maxima; the greater maximum occurring when the carbon is positive, and an instant slightly lagging behind the instant of maximum power expenditure in the arc. The second part of the paper consisted of a comparison of the efficiency of the alternate current arc regarded as a light-giving agent, as compared with that of a continuous current arc taking the same mean power. Using two arcs, which may be regarded as typical of those used in practice, the mean spherical candle-power was compared for equal expenditure of power in the arcs; and it was found that for the alternating current arc employed the total mean spherical candle-power was always less than that of the continuous current arc. Lowering the frequency seemed to decrease the efficiency of the alternating current arc. Prof. Ayrton said the behaviour of the alternate current arc was of great interest, for the power supplied could not be measured by simply multiplying the current by the electro-motive force, since the current lags behind the volts. The resistance, *i.e.* the ratio of the current to the E.M.F., also lags, but the authors do not appear to have made any attempt to measure the *true* resistance. The authors were to be congratulated on the guarded tone they had adopted as to the bearing of these experiments on the question of the relative efficiency of the alternating and continuous current arcs. In a previous communication, one of the authors had stated that the alternating current arc must necessarily be a less efficient light-producing agent than the continuous current arc. Although the last set of curves given in the paper might appear to support this supposition, he (Prof. Ayrton) felt that the difference obtained was probably due to the fact that the alternating current arc was not being worked under proper conditions. The quality of the carbons and the length of the arc have a most important influence on the efficiency of an arc. At present our knowledge is not sufficient to allow of our stating definitely whether or not an alternating current arc can be made as efficient as a direct current arc, but there is no doubt that it will be possible to get much better results than are at present attainable. Prof. S. P. Thompson said that when the fact of the existence of the difference in phase between the current and volts in an alternating arc was first published, he had made some experiments which showed that there was a lag and not a lead, *i.e.* that the arc acted as if it possessed self-induction. The resistance also lagged, and he thought this lag might be due to a thermal lag. The temperature of the arc will lag behind the current, both when it is increasing and when it is decreasing, and if the resistance of the arc depends on the temperature of the vapour in the arc, then the resistance would also lag behind the current. It was not possible from *à priori* reasoning to say whether or no an alternating current arc could ever be obtained of an efficiency equal to that of the direct current arc. With suitable carbons, length of arc, current and volts, it seemed to him that it might be possible to obtain an equal efficiency. The light-giving process in an arc is not merely an irreversible degradation of electric energy into heat, for the difference of potential between the carbons may be written $V = a + bl$, where a may be regarded as a back electro-motive force and bl as a true resistance. The first term of this expression does not vary with the length of the arc (l), but the second term does. Multiplying through by the current (C), the equation: Watts expended $= Ca + Cbl$, is obtained. It is the first of the terms on the right-hand side, which is a reversible effect, and corresponds to the power expended in driving the current against a back electro-motive force, on which the light given out chiefly depends, due to something occurring at the crater surface. Mr. Blakesley asked whether Prof. Thompson's idea of the light being due to the reversible part of the process was not a strong argument in favour of the direct current arc. Prof. Ayrton said that in two communications made to the congress held at Chicago, it was shown that even with direct current arcs there was a certain length of arc for which the efficiency was a maximum. Mrs. Ayrton had quite recently found that the efficiency of arc-lamp carbons altered with time. Prof. Thompson's suggestion as to a thermal lag was a valuable one. Prof. Fleming, in his reply, said that when comparing two agents where there were so many variables it was practically necessary to restrict the investigation. In their case they had kept the mean power constant, and had left the other variables to take care of themselves.—The Society then adjourned till March 13.

PARIS.

Academy of Sciences, February 24.—M. A Cornu in the chair.—On partial differential equations of the second order with imaginary characteristics, by M. E. Picard.—On the radiations emitted by phosphorescence, by M. H. Becquerel. An experimental proof of the fact that light emitted by phosphorescent substances possesses the power of affecting a photographic plate through a screen which is opaque to sunlight.—On the carbide of manganese, by M. H. Moissan. This carbide, Mn_3C, which is easily prepared in the electric furnace from Mn_3O_4 and sugar charcoal, differs from other metallic carbides in the simplicity of its reaction with water, which proceeds thus,

$$Mn_3C + 6H_2O = 3Mn(OH)_2 + CH_4 + H_2.$$

Neither acetylene nor liquid hydrocarbons being formed.—Study of the borides of nickel and cobalt. The borides, NiB, CoB, are easily obtained in the crystalline state from the metal and boron at 1200°, their properties being very similar to those of the iron boride previously described.—On the estimation of arsenic, by M. A. Gautier. A criticism of a paper by MM. Engel and Bernard upon the same subject.—On a colloidal substance elaborated by the lymphatics in the normal state, by M. L. Ranvier.—The relation between muscular work and the albuminoid materials of the body, by M. A. Chauveau.—An experimental study of the question as to whether albuminoids take part in the production of external work. The results show that the amount of nitrogen secreted is practically the same whether the animal is doing external work or not, and thus confirming the conclusion drawn by the author from previous experiments, that it is by the combustion in the muscle of carbohydrates that the energy necessary for external work is produced.—On the corals of the Gulf of Lyons, by M. de Lacaze-Duthiers. A communication from the Arago Biological Laboratory.—On the method employed for conferring immunity from the venom of serpents, from documents furnished by M. de Serpa Pinto, by M. d'Abbadie. A question of priority.—Observations of Venus on Mount Mounier, by M. Perrotin. The results of these observations, which were made under very favourable conditions at a height of 9000 feet above sea-level, are consistent with the slow rotation discovered by M. Schiaparelli.—On the conversion of dextro-rotatory camphoric acid into dextro-rotatory camphor, by M. A. Haller.—Analysis, by volumetric methods, of a mixture of chlorides, hypochlorites, and chlorates, by M. A. Carnot.—Analysis of a mixture of chlorides, chlorates, and perchlorates, by M. A. Carnot.—Observations on the new Perrine comet (1896, Feb. 15) made at the Observatory of Lyons, by M. G. Le Cadet.—Observations on the same, made at the Observatory of Toulouse, by M. F. Rossard.—On the production of Röntgen silhouettes, by M. C. V. Zenger.—On the action of the X-rays on the diamond, by MM. A. Buguet and A. Gascard. The transparency of the diamond and of jet to the Röntgen rays renders it very easy to distinguish them from their imitations, the latter being opaque.—On the cause of the invisibility of the Röntgen rays, by MM. Dariex and de Rochas. It was found that the media of the eye, although perfectly transparent to ordinary light, are nearly opaque to the X-rays.—On the Röntgen rays, by M. G. Meslin.—On some properties of the X-rays of M. Röntgen, by M. H. Dufour. The phenomena are compared to the silent discharge.—On the emission of the Röntgen rays by a tube containing a fluorescent substance, by M. Piltchikof. The length of exposure may be much reduced under these conditions.—On some properties of dark light, by M. G. Le Bon.—On photography through opaque bodies, by MM. A. and L. Lumière. The authors, in attempting to repeat the experiments of M. G. Le Bon, obtained entirely negative results.—On the properties of metals extracted from their amalgams, by M. Guntz (see Note, p. 423).—Action of some hydrogen compounds on sulphuryl chloride, by M. A. Besson. The reactions with hydrogen sulphide, bromide, iodide and phosphide were studied.—On the dry distillation of wood by

M. E. Barillot.—On the temperature of the sparks produced by uranium, by M. Chesneau.—On a new mode of formation of nitroprussides, by MM. C. Marie and R. Marquis. A mixture of an alkaline ferrocyanide and nitrite is treated with carbon dioxide.—On a crystallised ammonio-chromous carbonate, by M. G. Baugé.—On veratrylamine, by M. C. Moureu.—Thermochemical study of orthochlorobenzoic acid and some of its derivatives, by M. P. Rivals.—Conversion of formaldehyde solution into vapour for disinfecting purposes, by M. A. Trillat.—On the Cretaceous fossils of Madagascar, by M. C. Deperet.—Modifications in the structure of some Arthropods induced by their living in caves, by M. A. Viré.—On phagocytosis in the oyster, by M. J. Chatin.—On the combined action of light and water in the disengagement of the perfume of plants, by M. E. Mesnard.—Method for preventing the darkening of cider, by MM. L. Dufour and L. Daniel.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MARCH 5.

ROYAL SOCIETY, at 4.30.—Contributions to the Mathematical Theory of Evolution. Note on Reproductive Selection: Prof. Karl Pearson.—On the Diurnal Periodicity of Earthquakes: C. Davison.

ROYAL INSTITUTION, at 3.—Masters of Modern Thought. I. Voltaire: Rev. William Barry.

LINNEAN SOCIETY, at 8.—Segmentally-disposed Thoracic Glands in the Larvæ of Trichoptera: Prof. Gustav Gilson.

CHEMICAL SOCIETY, at 8.—On the Explosion of Cyanogen: H. B. Dixon, E. H. Strange, and E. Graham.—On the Mode of Burning of Carbon: H. B. Dixon.—On the Detonation of Chlorine Peroxide: H. B. Dixon and J. A. Harker.—The Constitution of a New Acid resulting from the Oxidation of Tartaric Acid: H. J. H. Fenton.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, MARCH 6.

ROYAL INSTITUTION, at 9.—The Tunnel under the Thames at Blackwall: A. R. Binnie.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—A Plan for the Geographical Description of the British Islands on the Basis of the Ordnance Survey: Dr. Hugh Robert Mill.

GEOLOGISTS' ASSOCIATION, at 8.—"Pebbly Gravel" from Goring Gap to the Norfolk Coast: A. E. Salter.—On some Pleistocene Ostracoda from Fulham: Frederick Chapman.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, MARCH 7.

ROYAL INSTITUTION, at 3.—Light: Lord Rayleigh, F.R.S.

SUNDAY, MARCH 8.

SUNDAY LECTURE SOCIETY, at 4.—The New Far East; the War between China and Japan: its True Meaning and its Results: Arthur Diósy.

MONDAY, MARCH 9.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—On the Country of the Shans: Colonel R. G. Woodthorpe, C.B., R.E.

TUESDAY, MARCH 10.

ROYAL INSTITUTION, at 3.—The External Covering of Plants and Animals: Prof. Charles Stewart.

SOCIETY OF ARTS, at 8.—English Book Illustrations, 1860-70: Joseph Pennell.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Paper to be further discussed: On Littoral Drift in relation to River-Outfalls and to Harbour-Entrances: W. H. Wheeler.——Papers to be read, time permitting: The Lixiviation of Silver Ores: J. H. Clemes.—Mining and Treatment of Copper Ore at Tharsis, Spain: C. F. Courtney.—Tin Smelting at Pulo Brani, Singapore: Messrs. J. McKillop and T. Flower-Ellis.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Some Account of the Shans and Hill Tribes of the States on the Mekong: Colonel R. G. Woodthorpe.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Notes on Medical Photo-micrography: Edmund Roughton and Charles Cosens.

ROYAL VICTORIA HALL, at 8.30.—Railways and Railway Men: Sidney H. Wells.

KING'S COLLEGE FREE LECTURES, at 8.—Romance of Plant Life: Prof. Bottomley.

WEDNESDAY, MARCH 11.

SOCIETY OF ARTS, at 8.—Peasant Life and Industries in Ireland: Prof. A. C. Haddon.

GEOLOGICAL SOCIETY, at 8.—On an Alpine Nickel-bearing Serpentine with Fulgurites: Miss E. Aston, with Petrographical Notes by Prof. T. G. Bonney, F.R.S.—The Pliocene Glaciation, Pre-Glacial Valleys, and Lake-Basins in Subalpine Switzerland: Dr. C. S. du Riche Preller.—Notes concerning certain Linear Marks in a Sedimentary Rock: Dr. J. E. Talmage, F.R.S.

PHARMACEUTICAL SOCIETY, at 8.30.

THURSDAY, MARCH 12.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: Observations upon Isolated Nerve: Dr. A. D. Waller, F.R.S.

MATHEMATICAL SOCIETY, at 8.—On the Enumeration of Groups of Totitives: Prof. Lloyd Tanner.—(1) The Catenary on the Paraboloid and Cone; (2) The Motion of the Top: Prof. Greenhill, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—High-Voltage Lamps and their Influence on Central Station Practice: G. L. Addenbrooke.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, MARCH 13.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Tests of Centrifugal Pumps: J. C. Cornock.

SATURDAY, MARCH 14.

ROYAL INSTITUTION, at 3.—Light: Lord Rayleigh, F.R.S.

ROYAL BOTANIC SOCIETY, at 3.45.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Annuaire de l'Observatoire Royal de Belgique, 1896 (Bruxelles).—Elements of Botany: J. Y. Bergen (Ginn).—The Geology and Scenery of Sutherland: H. M. Cadell, 2nd edition (Edinburgh, Douglas).—A Contribution to our Knowledge of Seedlings: Sir J. Lubbock, popular edition (K. Paul).—Life, Letters, and Works of Louis Agassiz: J. Marcou, 2 Vols. (Macmillan).—Grundriss der Psychologie: W. Wundt (Leipzig, Engelmann).

PAMPHLETS.—Report on the Scientific Study of the Mental and Physical Conditions of Childhood (London).—Esperienze coi Raggi di Roentgen: J. Vicentini and G. Pacher (Venezia).—Hermann von Helmholtz's Untersuchungen über die Grundlagen der Mathematik und Mechanik: Dr. L. Koenigsberger (Leipzig, Teubner).—Travaux du Réseau Météorologique du Sud-ouest de la Russie, 1894: A. Klossovsky (Odessa).—Annales de l'Observatoire Météorologie de l'Université Impériale de Odessa, 1894: A. Klossovsky (Odessa).

SERIALS.—Journal of the College of Science, Imperial University, Japan, Vol. viii. Part 2; Vol. ix. Part 1 (Tōkyō).—Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie, Einundzwanzigster Band, 4 Heft (Leipzig, Engelmann).—Himmel und Erde, February (Berlin, Paetel).—Bulletin de la Société Imperiale des Naturalistes de Moscou. 1895, No. 3 (Moscou).—The Photographic Times, February (New York).—Sunday Magazine, March (Isbister).—Good Words, March (Isbister).—Longman's Magazine, March (Longmans).—Quarterly Journal of Microscopical Science, February (Churchill).—Chambers's Journal, March (Chambers).—National Review, March (Arnold).—Century Magazine. March (Macmillan).—Natural Science, March (Rait).—Humanitarian, March (Hutchinson).—Zeitschrift für Physikalische Chemie, xix. Band, 2 Heft (Leipzig, Engelmann).—Transactions of the American Microscopical Society, January (Buffalo).—Contemporary Review, March (Isbister).—Scribner's Magazine, March (S. Low).—History of Mankind: F. Ratzel, translated, Part 6 (Macmillan).—Bulletins de la Société d'Anthropologie de Paris, 1896, Fasc. 5 (Paris, Masson).—Fortnightly Review, March (Chapman).

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THURSDAY, MARCH 12, 1896.

A GLACIAL HANDBOOK.

Ice-Work Present and Past. By T. G. Bonney, D.Sc., F.R.S., &c. Pp. xiv + 296. (London: Kegan Paul, Trench, Trübner, and Co., Limited, 1896.)

THIS latest addition to the familiar red volumes of the International Scientific Series is in many respects a model of what we may take to be the aim of the whole series. An exposition of the results of modern research and modern thought, which shall be of an unrestricted and international character, written without offence to prejudices or persons, is no mean task for an author to set before himself. And when the subject approaches the chilling atmosphere of the ice-age, we know how frequently the scientific soul waxes warm, and fortifies itself towards the inevitable conflict; while the outer world exclaims,

"That is hot ice, and wonderous strange snow."

Has it been left for Prof. Bonney to "find the concord of this discord"?

The aim of the author in this instance is to give prominence "to those facts of glacial geology on which all inferences must be founded." He begins most appropriately with a description of a "gathering-ground of glaciers" in the Bernese Oberland, a scene as familiar to himself as Bedford Square or King's Parade must be to many of his readers. A sober restraint is put upon his powers as a word-painter, and we have a condensed account of ice and ice-work in Switzerland, crisp and clean as the surface of the snows themselves. It is true that the irrepressible faculty of imagination breaks out occasionally, seeing more before it than the upturned face of the student; and the contrast is almost too abrupt, it betrays the effort at conciseness. Thus we are uncertain whether the "struggle of Solferino" (p. 35) refers to a meeting of descending glaciers, or to the events of recent history, since all the other references in the sentence are to purely geographical features.

In this first chapter, certain conclusions are drawn from the facts described, but so delicately and naturally that they seem to involve no controversy. A confidence is thus established between us and the author, and we follow him with the secure feeling that theories may be suggested, but will not be thrust upon us. If a writer has formulated any opinion of his own, this is the very happiest method of securing a hearing for it.

The second chapter deals with the larger phenomena of arctic and antarctic regions. To some extent this traverses the ground of Prof. Wright's corresponding chapter in "Man and the Glacial Period"; but additional matter is introduced, even in dealing with Alaska. Attention is very properly drawn to the feeble character of the "ground-moraine" in areas covered by an ice-sheet, and to the great accumulation of the materials, in the form of a terminal moraine, as the glacier retreats, when they become (p. 48) "drawn very gradually, like a coverlet, over the bed of the valley." On p. 57, another point of first importance is set down with characteristic delicacy; "it is therefore obvious that in all speculations as to the condition of any region during the Glacial Epoch, account must be taken of the possibility of a not inconsiderable difference in either direction from its present level." The evidence bearing on this subject has been so freely overlooked by those who have felt it easier to accept enormously thick ice-sheets, rather than differential earth-movements, that this innocent little sentence suggests in reality a controversy ranging over both the hemispheres.

The description of the Malaspina Glacier near Mount St. Elias in Alaska, quoted from Mr. Russell, naturally forms the most interesting feature of this chapter. The term "Piedmont Glacier" (p. 68), as it happens, would have been explained more clearly in Mr. Russell's own words. Since the date at which Prof. Bonney wrote this account of the Chaix Hills, with their uplifted marine glacial gravels, he has examined the additional evidence of post-glacial elevation brought forward by Colonel Feilden from Kolguev Island (*Quart. Journ. Geol. Soc.*, London, vol. lii., 1896, p. 57).

After this review of "existing evidence," Part II. describes the "Traces of the Glacial Epoch." The discussion of the origin of lake-basins is concerned with the greater lakes of the world, and the summing-up is in favour of their hollows having been caused by earth-movements. Eskers are dealt with in the same chapter, and the accumulation of sands and gravels in the very areas claimed by some authors as regions of excavation is, in conclusion, neatly pointed out. After Mr. Russell's description, quoted on p. 74, we are left somewhat in the dark (p. 116) as to the probable origin of eskers. The names of Hummel and Holst might well have been quoted in connection with the theories for which they are respectively responsible; and Ireland is so eminently a land of eskers, that one is inclined to ask for a view or section of an esker of home-manufacture, instead of the figure from New Hampshire given us on p. 110.

Why, again, in the next chapter, headed "Ice-work in Great Britain and Ireland," is till illustrated from "Seattle, Washington State," except for the fact that Prof. Wright's block is in the possession of the publishers of this series? All through, Prof. Bonney has been somewhat badly treated in the matter of illustrations. The Alpine drawing in Prof. Wright's book is painfully rigid and antique, and we should consequently have welcomed a photographic view of the Aletsch Glacier to illustrate Prof. Bonney's description. The frontispiece, showing the results of ice-work, is the only novelty of the kind. Even the scratched blocks figured are not from Finchley, or Snowdon, or Glencullen, but from "the till of Boston," which seems far away from an English author, even in an international scientific series.

Such drawings as are given had a special interest when put before us by Prof. Wright; but it is hard that Prof. Bonney, who has trained a full generation of geologists in England, and to whom the Alpine heights are as a garden, should be compelled to select his most effective illustrations from those of an American predecessor. A few views of English boulder-clays, and erratics, and *roches moutonnées*, as they actually appear, would have been at least refreshing. Our students know far too little of their own islands; and, in the case of Ireland, such pictures would have been absolutely novel.

On p. 126, "till" is distinguished from "boulder clay," and Prof. James Geikie is quoted in support of this position; but the reference is to the first or second edition of the "Great Ice Age," since in the third the distinction is abandoned. The third edition is quoted, however, but again without exact specification, on p. 109.

In describing the principal accumulations due to glacial action in our islands, it would be impossible to follow all the literature that has been poured forth in recent years. Prof. Bonney seems to have made a fair and wide selection, perhaps leaving some extreme views charitably alone; throughout, he describes rather than theorises, and follows out, with steady self-denial, the line of work on which he started. From p. 163 to p. 205, we have a discussion of the opinions of other authors; but we read on with a sense that behind all this exposition there is a guiding mind, gently and steadily influencing our own. Yet it seems that no one can complain of having been misrepresented, which is about as much as Prof. Bonney can hope for, when we look back on the amenities of glacial warfare.

The description of the centres of radiation of boulders of various types (pp. 151–161) would be made of singular value to all students, if, in a second edition, a plate showing typical microscopic sections of the rocks referred to could be inserted. In this connection, we note a curious remark in the foot-note on p. 140, where Ailsa Craig is said to be "too small a place to have furnished numerous specimens to such a distant locality." Megascopic and microscopic examination has again and again proved the occurrence of erratics of the Ailsa rock, not that of Mynydd-mawr, as far south as Greystones on the Irish coast, and their existence was thus proved even under Mynydd-mawr itself. The very smallness of Ailsa Craig may surely be adduced in favour of the view that these abundant blocks have been worn away from it. Of course, some of these boulders may have come from the Riebeckite-eurite of Skye; but of this there is as yet no evidence. Here we touch one of the most frequent paradoxes in glacial essays—boulders are assumed to have come from the self-same levels where similar rocks are now exposed. The frequency of the boulders themselves is a fair measure of the former extension of the rock in question, even if we neglect any possible differential earth-movements.

A somewhat startling omission occurs on pp. 200 and 202, where what we may almost style the life-work of Mr. Maxwell H. Close is attributed inadvertently to Prof. Hull. The wide distribution of the "sands and gravels" in Ireland might perhaps have been further emphasised; but the recent observations of Prof. Sollas on Irish eskers find an appropriate place in the concluding sentences of this section.

Chapter iii. of this part goes further afield, particular attention being given to the wide-spread glacial phenomena in North America. And then we find the vexed "Theoretical Questions" summed up in Part III., conveniently shut in by themselves. The concluding words of the chapter dealing with temperature in glacial times again calls attention to the dependence of the successive stages of the cold period upon the variable level of the land; and, similarly, the next chapter on the "causes of a glacial epoch" closes judicially with the statement that probably "some factor which is essential for the complete solution of the problem is as yet undiscovered, or, at any rate, the importance of one which is already known has not been duly recognised."

The final pages of this admirable book, the strength of which lies largely in its reserve, point to a closer study of Greenland as essential to the solution of our problems. Already some comment has been made, through the latest of researches, on the question raised by Prof. Bonney (p. 135) as to the possibility of stratification in the deposits of land-ice. The spirit in which the author has shown how the field is open to the future should now attract a new band of workers, unfettered by their own past utterances.

Critics are most likely to lay hold of the treatment of contemporary literature, when looking for a weakness in this little volume. We have already indicated that the exactitude of a librarian is not always noticeable in the references, and various editions are not separately quoted. On p. 90 the title of Mr. Whymper's book is not precisely given, and the most important reference to the subject is in chapter xvi., not chapter vi.—at any rate, in the last edition. It is not clear from what work a passage on p. 114 is quoted; the reference should be to James Geikie, "Great Ice Age," third edition, p. 171. On p. 139, we might have liked a reference to some of the later literature on Moel Tryfaen, perhaps to Mr. Mellard Reade's examination of the microscopic materials, or to Miss Andrews's record of foraminifera. The difficulty as to the mingling and crossing of erratics borne by land-ice (p. 171) has been to some extent met by an important paper by Prof. Jas. Geikie, published in the *Scottish Naturalist* in 1881, and in "Fragments of Earth-Lore" in 1893. Why, again, are the figures on p. 21 quoted from an abstract in the *Alpine Journal*, and not from Heim's own book? The reference-figure is so placed on the page as to include a calculation which seems really due to Prof. Bonney. And here and there quotations from other authors have not been checked, so that, as they stand, they are not absolutely accurate. The only important case of this kind, however, seems the slip of "shale" for "strata" on p. 70, second line from bottom.

When, in this seemingly trivial manner, we think we have found a plane of weakness in Prof. Bonney's treatment of "Ice-Work Present and Past," it is like pointing out that David, another standard author, was injudicious in discarding the full panoply of armour. The writer of so many voluminous and yet precise papers in our geological journals has again and again protected himself from this attack. He has displayed a generous indifference as to the originality of any statement he may put forth, and has thereby doubtless lost considerable credit which he might otherwise have gained, as well as opportunities for trenchant criticism. "If any one," he wrote in 1890, "has come to conclusions identical with my own, I can assure the author that there is no plagiarism." In 1886, the matter was put still more clearly. "If," Prof. Bonney wrote, "there is any value in my results, it will be that they have been obtained, as far as possible, independently, and sometimes actually in ignorance of the work of others."

This standpoint is heroic, and involves considerable sacrifice of self; the argument has so obviously two sides to it. Is it a wise one to reiterate before us, juniors and pupils as we are; and shall we not remember how in many cases it was from Prof. Bonney that we received our first literary encouragement? Who amongst us, however, shall pose as his critic in this matter? Rather let us ask it of him as a question.

GRENVILLE A. J. COLE.

PHILOSOPHY AND EVOLUTION.

Evolution and Man's Place in Nature. By Henry Calderwood, LL.D., F.R.S.E. Second edition. Pp. xx + 316. (London: Macmillan and Co., 1896.)

IT is not often that the author of a work on science or philosophy so far accepts the verdict of his critics as to entirely re-model and re-write his book. Much to his credit Prof. Calderwood has done this, for the second edition now just issued is not only nearly twice the bulk of the first, but is also full of new matter, and is greatly improved in its scope and arrangement. The first edition (reviewed in NATURE, vol. xlvii. p. 385) contained eight chapters, while the present work has seventeen, the titles and "contents" of which are so different that the two books seem to have little in common. The chapters on "The Nerve System as an Instrument of Knowledge," "Right and Wrong," "Civil Law," "Modern Thought," "The Ape and Man," and "Cosmic Problems," seem to be wholly new and to embody the results of the most recent researches. In other respects the present work is far superior to the former edition, as it not only gives a much larger body of facts, and contains less repetition, but is a more complete presentation of the whole subject, treated from the point of view of philosophy rather than from that of science.

The author's style, which leads him always to go round about a subject rather than to the heart of the problem itself, to take much for granted which requires systematic proof, and to revel in diffuseness of phraseology and of argument, is still a prominent feature, and is wearisome to the reader who wants to get at the author's conclusions and to have a clear presentation of the facts and arguments on which they are founded. But to those who enjoy diffuse philosophical discussion, and especially to those who want a reply to the supposed materialistic tendencies of the works of Darwin and Herbert Spencer, there is here much food for thought. A few passages will serve to illustrate the author's merits as well as his limitations. In the chapter on "Right and Wrong," he thus explains his view of the essential difference between the human and the animal nature.

"The grand distinction of human life is *self-control in the field of action.* Thought not only reaches a generalised knowledge of existence, and of its laws; it leads to rationalised action, within the many and varied fields of human endeavour. The evidence of this appears, as already described, in the control exercised over all the animal impulses, so that these do not spontaneously and of themselves determine activity. Sensibility operates in human life, just as in the life of the animal; but it does not at once direct our action, as the course of the dog is ruled by sense of smell. Sensibility can influence us in the same way, and a similar result is often seen in our life; but that which is peculiar to man is a concentration which overcomes allurements of sense. Animal appetite is stirred in us, as in animals, physiological law being coextensive with the animal kingdom; our speciality appears in the regulation of animal impulse, so that it is repressed, in accordance with the laws of attention, which weaken or strengthen animal propensity; or limited by reference to propriety; or regulated in its indulgence in recognition of a law higher than present desire. These facts are so familiar, that I have only to refer to them to claim their weight of evidence for a power which does not appear in animal life. The value of this evidence will be still more appreciated, if it be observed that the control of animal impulse no more belongs to the animal nature of man, than it belongs to the animals around him. In respect of animal impulse, his experience is as much determined by physiological law, as animals are visibly moved by it. Man being an animal, no one can suggest that the movements of animal impulse are otherwise determined or have their source elsewhere than in the body. The difference between man and animals appears in this, that by thought and imagination passion may be intensified; and by use of these powers it can be restrained. Even within the sphere of passion, the elevation of human life is seen in the control the rational power wields over the animal nature."

The purport of this wordy and laboured passage is clear enough, but its cogency as an argument is certainly not proportioned to its length. The same idea is pursued through two other paragraphs of equal length, but these do not bring any further sense of completeness to the presentation of the subject.

One more extract may be given from the final chapter on "Cosmic Problems."

"With clearest testimony, scientific observation has led us to innumerable points, whence we have seen intelligent purpose at work providing for life yet unborn. We have been arrested first, and afterwards roused to quickened consciousness, realising that we have seen the lesson all the days of our life, in hundreds of forms, but had not read its full meaning, though it had been written large; for is not the whole vegetable kingdom confessedly a preparation for a coming life? In vain does Agnosticism lift its voice in presence of witness such as this. Testimony for an Intelligent cause springs even from the *dust*, and, as it comes thence, thought moves freely along all fields of science, gathering evidence as readily from the vegetable kingdom as from the animal; finding, with ever-increasing surprise, a growing testimony as science conducts us lower in the knowledge of nature. Not to the heights but to the depths we go, in order to witness the most startling condemnation of Agnosticism. It is not merely the myriad dwellers in the insect world which bear witness; but the inanimate creation itself tells us of treasure stored in its keeping, to satisfy animal wants. Plants can manufacture fresh protoplasm out of mineral compounds, whereas animals are obliged to procure it ready made, and hence in the long run depend upon plants. Thus, even from the *soil*, under our feet, comes the evidence calling us to own an Intelligent First Cause."

A number of illustrations, of the lower forms of life, of the sense organs of various classes of animals, and of the brains of many of the mammalia and of man, will render the work more attractive to those who have not acquired a general knowledge of the subject from other sources.

A. R. W.

OUR BOOK SHELF.

Experimental Plant Physiology. By D. T. MacDougal. (New York: Henry Holt and Co., 1895.)

THIS little book is intended primarily for the use of elementary students of vegetable physiology, and the subject-matter is treated in a somewhat dogmatic fashion. This we cannot avoid regarding as a mistake. The elementary, no less than the more advanced, student requires to be made at the outset to *think for himself*, and this is a far more important matter than the mere following out of directions for experiments. But it is just this stimulus that we miss, in the pages before us, and in not a few instances the author has sacrificed reality at the shrine of conciseness; thus it is simply useless to compare the mechanism by which water "is taken up and forced into the root and upward in the stem" to the action of an osmometer, for the conditions are not at all the same. The state of the water, as it exists in, and finds its way upward into, the tracheids, is by no means directly comparable with that of the solution of salts as it occurs in the tube of a thistle funnel, the lower end of which is closed by a piece of membrane. Here was a good opportunity of insisting on the peculiarity of a living protoplasmic structure, and it was lost. Very few teachers, who are at all *au courant* with their subject, will accept the statements as to ascent of sap, given on pages 28 and 29. "The rectangular wood cells are in the form of a series of chains. Water transpired from the topmost cells of these chains, the cell sap becomes concentrated. . . . There is thus formed a series of osmometers extending from the leaves to the roots and capable of lifting water to any height." Surely a slight knowledge of elementary physics, combined with that of the structure of the "wood cells," should have rendered it impossible that such a passage could have been written.

Again on page 46, one is tempted to wonder whether the author can have ever tried the experiment (54) to prove that oxygen is necessary for *respiration*. Any unwary teacher who performed that experiment for the first time before an intelligent class, would probably have a hard time of it if he trusted himself to Mr. MacDougal's guidance.

The above remarks and quotations will show that there are weak points about the book. And, indeed, the general impression left on the reader's mind is the rather painful one, that an important branch of botanical study has here been but superficially handled.

Exercises in Physical Measurement. By Dr. L. W. Austin and Dr. C. B. Thwing. Pp. x + 193. (Boston: Allyn and Bacon, 1896.)

AFTER working through the experiments described in this volume, a student will have a thorough knowledge of the instruments and methods employed in physical measurement, and will be in a position to accurately investigate physical phenomena. The book is a medium between such a hand-book as the last edition of Kohlrausch's "Praktische Physik" and the elementary text-books in which mathematical formulæ are eschewed. The sixty-five exercises in the first part are all quantitative, and they cover measurements in the chief branches of physics, beginning with measures of length, and ending with experiments on polarisation; while the apparatus required for the experiments should form part of the equipment of all physical laboratories in which students can obtain scientific instruction.

In the second part of the book suggestions are given as to methods of computation and physical manipulations, while the third part is taken up with tables. The book is thoroughly practical and trustworthy, and it can be recommended as a suitable introduction to serious work in physics.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Age of the Wealden.

THE Wealden formation of England has long been studied, and is now well known in nearly all its features. Its stratigraphical relations and its Cretaceous age are usually regarded as fully determined, and this is true, also, of the corresponding strata on the continent.

The vertebrate fauna of the Wealden is of special interest, and has attracted much attention ever since Mantell in 1825 unearthed Iguanodon in the Tilgate Forest. Some of the remains, he sent, through his friend Prof. Silliman, to Yale College, where they have proved of much service. In 1865, I examined the same famous locality, as well as others on the south coast of England especially rich in vertebrate fossils, and at all of them secured interesting specimens. A study of these in connection with the collections at London and Brussels first caused me to question the Cretaceous age of the Wealden, and a later comparison of its reptilian fauna with allied forms found in the Rocky Mountains led me to the conclusion that both series were Jurassic in type, and should be placed in that division of the geological series.

At the meeting of the British Association at Ipswich, in September last, I read a paper on European Dinosaurs, including two from the Wealden, and thus the question of their geological age came up for determination. The facts I then presented, based mainly upon the reptilian fauna, strongly indicated the Jurassic age of the Wealden, and I urged a re-examination of the question by English geologists. The subject has since been taken up by Smith Woodward, with special reference to the fossil fishes. In the *Geological Magazine* for February 1896, he gives the main results of his investigation, which prove that the fishes, also, of the Wealden are of Jurassic types, thus placing the geological age of this formation beyond reasonable doubt. The concluding statement of this interesting article is as follows:

"The Wealden estuary seems to have been the last refuge of the Jurassic marine fish-fauna in this part of the world, not invaded even by stragglers from the dominant race of higher fishes which characterised all the seas of the Cretaceous period. The Wealden river drained a land where a typically Jurassic flora flourished; the only two known Mammalian teeth from the Wealden resemble those of a Purbeckian genus; and now it is clear that the fishes agree both with these and the reptiles in their alliance with the life of the Jurassic era." O. C. MARSH.

Yale University, New Haven, Conn., February 22.

The Röntgen Rays.

THE following fact regarding the X-rays of Röntgen may be of interest.

I have found that it is possible to obtain a photographic image by these rays, using a "pinhole camera," having the aperture pierced in a piece of sheet-lead backed with aluminium. The Crookes' tube was illuminated by discharges from a Thomson high-frequency coil. The photographs taken in this way show very distinctly the two electrodes, while the glass bulb, which appeared to be brightly illuminated to the eye, is scarcely perceptible It would appear from this that nearly, if not all, the so-called X-rays proceed directly from the electrodes of the tube, and not from the glass where this is acted on by the kathode rays. It likewise affords further illustration of the rectilinear motion of the X-rays. Experiments are in progress with a broken current, and also to study the effect of a magnetic field.

Previous observation has shown that photographic effects were produced equally whether the kathode rays impinged upon the glass, or upon other phosphorescent material (*e.g.* aragonite) within the tube. It has also been noticed in experiments in this laboratory, that the appearance of the tube to the eye affords no criterion of its efficiency in producing the X-rays; tubes showing but little fluorescence of the glass composing them often giving admirable photographic effects, which in some cases are obtainable even from a low-vacuum Geissler tube. But the rays

producing photographic effects always appear to produce strong fluorescent effects on platino-cyanide of barium, so that the fluorescence of this affords an indication of the photographic efficiency of the radiations emitted from the tube.

RALPH R. LAWRENCE.

Massachusetts Institute of Technology, Boston, February 26.

Is it quite correct, as Prof. Lodge puts it, to call the X-rays *anodic* because they start from a point (surface of glass, or of metal foil, &c.) opposite the kathode? It may be true that a surface upon which the kathodic discharges are being directed acquires thereby some properties common to the anode: but it is not an actual anode. Further, I think that so far there is no proof that these rays start from an anode unless that anode is itself in the line of the kathodic discharge. Hence I submit that *anti-kathodic* would be a more correct term to use in describing them. They can certainly be made to start from a portion of the kathode itself by shaping it so as to concentrate the kathodic discharges (or "radiant matter") upon a prolongation of itself.

Whilst dealing with this point, might I mention that a phosphorescent enamel, made by incorporating calcium sulphide in a very fusible enamel-glass, appears to form an excellent anti-kathodic surface for generating X-rays.

SILVANUS P. THOMPSON.

Finsbury Technical College, March 9.

WE enclose a print of a "Röntgen" photograph taken by us some time ago, which shows very clearly that it is to the mineral constituents that bone owes its opacity to the "X-rays." Two human finger-bones were obtained as nearly alike as possible. One was decalcified by treatment with dilute hydrochloric acid for some days, the other being soaked in water for the same period. The calcium phosphate, carbonate, &c., dissolved by the hydrochloric acid, were precipitated by ammonia and ammonium carbonate, and the precipitate, after washing, was spread on paper, so as to cover an area about equal to that which would be covered by the original bone. This precipitate, together with the bone which had merely been soaked in water, and the "decalcified" bone (which had shrunk during treatment with the acid), were then placed upon a photographic plate and exposed in a cardboard box to the radiations from a Crookes' tube excited by a small "Tesla" apparatus.

The picture thus obtained, shows clearly that while the decalcified bone is almost without action on the "X-rays," the mineral matter is practically as opaque as the bone before treatment with acid.

The print shows, however, that both the original bone and the calcium phosphate are only relatively opaque, but that they do allow some "rays" to pass, for the photograph shows half-tones, and not merely an outline.

J. D. CORMACK.
HERBERT INGLE.

The Yorkshire College, Leeds, March 4.

REMEMBERING that scientific men are pledged, beyond all others, to accuracy and observance of rule, I am emboldened to protest against the use of two words which are sometimes employed to describe the pictures produced through the agency of Röntgen's rays. I mean "shadowgram" and "radiogram."

Both of these offend against a primary rule for the formation of new compound words, which requires that all of the component parts of any word shall be derived from one and the same language.

If a word be desired which shall signify a picture produced by rays, let us go to the Greek language only, and form the word "actinogram"; or to the Latin language only, and form the word "radioscript"; or else let us be content with some purely English compound, such as "ray-sketch."

G. H. P.

The Aurora at Waterford.

AFTER a boisterous day and a barometer that went down to 28·85, we were favoured last (Wednesday) night with an auroral display. It was first seen here at 8 o'clock, when it appeared in a cloudless, starlit sky as a sheaf of light springing from the western point of the horizon, and stretching along an arc of 30° up towards the Pleiades.

Its colour, at first silvery white, gradually faded away, reappearing in thin streaks and irregular patches of yellowish light in various parts of the sky between north and west.

At 10.30, it was round in the north. At one time, six well-distanced streaks were counted. They seemed to converge slightly towards the zenith. The light was mainly yellowish, but tinged here and there with pulsating reddish rays. The flickering, or fluctuation in colour and brightness, was distinctly noticeable.

The phenomenon was not observed after 11.30.

As auroræ are essentially electrical in character, having some analogies with the brush discharge, it would be interesting to know whether, like the brush discharge from induction coils and influence machines, *shadowgraphs* might be taken by means of these weird rays. Opportunities for testing their photographic qualities occur very frequently in higher latitudes than ours, and even nightly in circumpolar regions, the home of this interesting phenomenon.

M. F. O'REILLY.

De La Salle Training College, Waterford, March 5.

An Unusual Meteor.

AT 8.31 on Sunday evening, March 1, when half a mile north of York Minster, I caught sight of a meteor slowly falling vertically almost due east. It was then passing over the two small stars ν and ξ Ursæ Majoris, which at the time were at an altitude of 43°, azimuth 5° north of east. Seeing that it meant to last awhile, I proceeded to repeat the alphabet in the orthodox manner (once through, each letter quickly but distinctly enunciated, requiring 4 seconds). Having gone over it twice, I must confess that my amazement at the meteor's duration made me pause. But it kept on, so I continued, getting through it twice more. Then, after a second involuntary but very unscientific pause, I finished the alphabet a fifth time before the phenomenon came to a close. In all, I must have watched it at least 25 seconds. After some 10 seconds, when about the same altitude as β Leonis (24°), a smaller meteor (fourth magnitude) appeared 1° to the left, at an angle of about 40°, and, proceeding at the same speed of under 2° per second, lasted 3 or 4 seconds. The original, of which this was doubtless a fragment, was between first and second magnitude, but with a distinct disc, and was followed by a train of sparks, reddish like itself, which was never more than 2° or 3° long, or lasting only 1 or 2 seconds. The fragment had also a slight train. The main mass seemed to pause slightly about this spot, perhaps because of this explosion. From the first it moved slower and slower, doubtless an effect of perspective, and finally disappeared almost due east (within 5° north of east), only 5° or so above the horizon, in the unusually clear sky just above the rising moon.

Whilst making notes, a gentleman came by, who said that he had seen it earlier, when as high as, and very near τ and μ Ursæ Majoris (the hind paw), or about an altitude of 58°, 5° north of east. Thus its angular path was 53°. As the additional distance was nearly half that observed by myself, it must have been visible for at least 7 seconds before I saw it, or 32 seconds in all. This makes due allowance for its apparently quicker motion at first. But the gentleman himself thought that he had not seen the actual commencement.

It is to be hoped that some other reports will be received, for its path must have been of extraordinary length, even if it was only travelling at ten miles per second, which is the almost irreducible minimum for a meteor.

A third observer saw it from indoors, appearing from above the window and falling vertically down the panes. It is a reasonable assumption, for a meteor of so great duration, that it first appeared at a height of 100 miles and reached within 30 miles of the earth. If so, its approximate path would be from above 25 miles off Bridlington to the coast of Denmark, north-east of Heligoland. The flight would be 360 miles, or rather over 10 miles per second.

Bootham, York.

J. EDMUND CLARK.

RECENT WORK OF THE GEOLOGICAL SURVEY OF THE UNITED STATES.

I.

OWING to the fact that much of the sphere of operations of this Survey lies in a new country, it is compelled to undertake a great deal of work of a class which does not usually fall to the lot of a body of geologists; chief amongst this stands topographical

work. It was found that large tracts of country were unmapped, or else that such maps as did exist were worthless for geological purposes; so the Survey set itself to produce the necessary maps, and a very considerable advantage is likely to accrue to the country from the two types of survey being directed by one organisation. A map that is good enough for the reception of geological lines, is capable of all the uses for which a small scale map is ever available, while the employment of men who understand something more of the origin and types of topographic features than map-makers usually do, must conduce to the more accurate generalisation and delineation of surface features.

It is from this point of view that the monograph of topographic methods by Mr. H. Gannett[1] is likely to be of considerable use, both on the staff of the Survey, for whom it was primarily designed, and elsewhere. In addition to giving a concise description of the chief instruments employed and the methods of using them, this work contains a set of logarithmic and other tables for use in the field, with a short account of the method of origin of the chief surface features; this shows the usual types of contour and outline special to different cases, and it is so written as to give those charged with the sketching of these features some rough guides for the better delineation of them. The same work gives a map to show the progress of the topographic map executed by the Survey, and the contributions toward this work by other bodies, such as the following: The survey of the Fortieth Parallel, Hayden's survey of the Territories, Powell's Rocky Mountain survey, the U.S. Coast and Geodetic survey, the U.S. Lake survey, the General Land Office, the surveys of various States, the Engineers of the U.S. Army, several railway, astronomical, and private surveys, and the Town and County maps.

The completed maps will be on the scales of one mile and two miles to the inch, and the size of the sheets will be so regulated that all sheets on the latter scale will contain one-half, and those on the former, one-quarter of a degree, both of latitude and longitude.

One of the bulletins[2] contains a series of sketch maps showing the systems of primary triangulation adopted by this Survey and its predecessors and coadjutors. Another most useful publication, also by the same writer, is a set of geographical dictionaries of the several States; of these, the following are already published: Rhode Island,[3] Massachusetts,[4] Connecticut,[5] New Jersey.[6] Each of these "is designed to aid in finding any geographic feature upon the atlas sheets of the State, published by the U.S. Geological Survey. It contains all the names given upon those sheets, and no other. Under each name is a brief statement showing the feature it designates and its location, and opposite to it is the name of the atlas sheet, or sheets, upon which it is to be found." The heights of many important points, the length of many streams, and the areas of townships are given. It need hardly be said that such a task as this is one which might with great advantage be taken up by the Ordnance Survey at home, and the exact latitude and longitude, as given on the map, might be added for the purpose of precision in location.

An article by Mr. Gannett, in one of the annual reports,[7] deduces from the contoured maps some useful estimates of the height of most of the States in the Union, and the average elevation of the whole country. From this we gather that, while the country contains 200,000 square miles under 100 feet in height, there are nearly 20,000 square miles above 10,000 feet. The largest part of the area, half a million square miles, is between 500 and 1000 feet; the loftiest State is Colorado, closely followed by Wyoming 6700, and Utah 6100 feet, while the average elevation of Delaware is but 60 feet. The average height of the United States is 2500 feet. This article is illustrated by a beautiful orographic map of the country.

Turning now to publications of a more strictly geological interest, we may say a word or two about their character as a whole. In addition to the maps, of which the issue has now begun—these consist of three sets, the annual reports, monographs, and bulletins—statistical papers on the mineral resources of the States are published annually as well.

It is not quite easy to see what is the guiding principle underlying the division of these different works. The monographs are of course reserved for important and original researches bearing on all branches of geology. The annual report contains an account of the work executed within the year, together with a collected set of the more important investigations completed within the same period. These do not appear to differ in any marked degree from the bulletins in character, while they are decidedly bulky and difficult to handle and read. They are, however, profusely illustrated, and may presumably be taken as the more popular of the publications —works intended to be used by those seeking for information on soils, water, mines, and such-like topics—and as containing the researches of interest to the ordinary citizen or reader. This idea seems to be borne out by the amount of rather rudimentary matter given, occasionally in somewhat high-flown language, in these papers. Presumably the form of language employed is well understood in the States; but, over here, one cannot help thinking that simpler language would be a more fitting garment for such elementary ideas. The bulletins as a rule contain simple and straightforward statements of fact, with theory kept well in subjection; they consist of descriptions of particular areas, accounts of work in the field, the laboratory or the cabinet, palæontological and correlation papers, and compact pieces of petrological investigation.

Hitherto the annual reports have been loaded with a mass of details which, after once being presented to Congress, need hardly have gone further, such as the travelling bills of each exploring party, and other statements of accounts. We are glad to notice that now the administrative report of the director and those of the heads of divisions are bound with that account in a separate volume, while for several years the work on irrigation has been placed within separate covers.

We pass now to papers dealing with physiography from a standpoint more or less geological, and generally with the idea of providing matter of use to the general public. In the first place stands the treatise by Prof. Shaler on soils.[1] After a preliminary description of the average soil and its composition as regulated by the amount of stony and organic constituents which it contains, certain types of soils are classified as follows:—

Cliff-talus soils.
Glaciated soils.
Volcanic soils.
Soils of recently-elevated ocean-bottoms.

The chief formative agencies are in each case described, and the peculiar suitability of certain soils for particular purposes, such as talus soils for vineyards, is

1 *Monograph* xxii., "A Manual of Topographic Methods," by Henry Gannett. (1893.)
2 *Bulletin* 122, "Results of Primary Triangulation," by Henry Gannett. (1894.)
3 *Bulletin* 115, "A Geographic Dictionary of Rhode Island," by Henry Gannett. (1894.)
4 *Bulletin* 116, "A Geographic Dictionary of Massachusetts," by Henry Gannett. (1894.)
5 *Bulletin* 117, "A Geographic Dictionary of Connecticut," by Henry Gannett. (1894.)
6 *Bulletin* 118, "A Geographic Dictionary of New Jersey," by Henry Gannett. (1894.)
7 Thirteenth Annual Report of the United States' Geological Survey, 1891-1892. (1893.)

1 Twelfth Annual Report of the United States' Geological Survey, 1890-91. (1891.)

pointed out. The author then turns to the slow disintegration of glaciated surfaces contrasted with the easily rotted and fertile volcanic soils, and describes the succession of vegetable organisms in reclaiming new soils, and gradually rendering them suitable for tillage, beginning with the most humble, and passing up to the more conspicuous plants, and those useful for the purposes of man.

We next proceed to the ordinary types of soil in the valleys and plains, and opportunity is taken to give the life-history of soil from its first separation from the parent rock, all through its slow journey down the hillside, until it passes out to the streams and the sea. The action of frost and rain, of snow and wind, of carbonic acid and oxygen, but not of the very important humus acids, is given in full detail, and the great importance of widespread forest vegetation in preparing the soil for subsequent tillage by deep disintegration is rightly insisted on. The pumping of air in and out of the soil by rain and evaporation is shown to be of vast use, not only to the larger plants, but to the bacteria and fungi, which are of such great import in the life and death of higher organisms.

A capital series of pictures illustrates this monograph; one can only wish that in all cases the localities were specified. The function of roots, whether alive or dead, is well described. Darwin's work on earth-worms is referred to, and the operation of beetles, ants, crawfish, burrowing birds, reptiles, and rodents dealt with. A section of the paper relates to deposited soils, and great stress is laid on the circulation of soil and the functions of materials, which are the survivals of rocks which may have long ago disappeared, but whose influence in the soil does not pass away for very long periods. Certain peculiar soils, such as those of swamps, marine marshes, and sand dunes, are not neglected, and prairie soils are explained as due to the destruction of forests by fire. Man and the soil succeeds, and it is pointed out how great an action and reaction there is between these two, so that not only the distribution of disease, but even that of slavery can be shown to have a distinct direction with the soil. The following words may be noted in conclusion: "A heedless neglect of our duty toward it has led to the destruction of the soil over an aggregate area of not less than 4000 square miles. This means the loss of food-giving resources which would be sufficient, with proper care, to support a population of about one million people."

Prof. Shaler contributes to another annual report[1] a valuable and original article on the geological conditions of harbours. The following types are of importance in the United States, and it would be easy to recognise them elsewhere:—

Delta harbours; the Mississippi.
Re-entrant Delta harbours; Mobile Bay.
Glacial or Fiord harbours; Cape Breton.
Mountain Range harbours; Lower California and North of Puget Sound.
Moraine harbours; East end of Long Island.
Lagoon and Sand-bar harbours; Chatham harbour.
Sand-spit and Travelling Beach harbours; Provincetown harbour on Cape Cod.
Coral Reef harbours; Florida and Atolls.
Volcanic Crater harbours; not known in the States.

Prof. Shaler points out how important good harbours are in developing a race of sailors, and through them acquiring commerce and influence. His text is pointed by reference to the fact that the English-speaking race, or their kindred, the Dutch, possess nine-tenths of the valuable islands beyond the limits of Europe, and that North Europeans bid fair in time to dominate every part of the world fit for their occupation. "These considerations make it plain that the way to national power is over the waves, and that this way is the natural path of our race."

It is essential that a good harbour should fulfil the following conditions:—

It should be protected from the incursion of heavy waves.

There should be a deep and roomy channel from the anchorage to open water.

There must be ample room to receive and discharge cargoes.

It should be convenient for access from the interior.

In addition to this, it should be roomy, not in the path of heavy currents, not liable to shifting channels or deposits, nor likely to be obstructed at any time by ice. Harbours may be injured in greater or less degree by floods, winds, tides, by movements of the solid land, and by the indirect consequences of all these causes. The great preservers are the scour of tides and currents; the great destroyers, sediment and the growth of organisms. The action of sediment is fairly well understood and allowed for by engineers, but the influence of animals and plants is here dealt with in more detail than we remember to have seen elsewhere. The protecting work of algæ and seaweed is thoroughly explained, and the "eel-grass" (*Zostera maritima*) described in detail; this seems to have great influence in arresting the deposit of sediment, and causing the silting-up of harbours. The general operation of the tide-water grasses is to diminish the area of the harbour, and to deepen the channels which remain; that of mangroves is to occlude the harbour by cutting out the storage of water at high tide. The destructive work of plants appears to far exceed that of polyps. The article concludes with a review of the whole coast-line of the States, and the origin of all the important harbours.

The article on potable waters, by Mr. McGee,[1] contains a good deal of useful information, from the building of cisterns to the fouling of well-water by cesspools. Direct rain-water supplies are first dealt with, and the necessary filtering, which such water needs, described; next stream-water, and then that from shallow and deep wells, the latter source being termed *phreatic* water, whether from deep-seated springs, from artesian wells, or deep-pump wells.

Dr. A. C. Peale, who has done such an immense amount of unassuming and scarcely appreciated work for the survey in past years, contributes a much more important paper on natural mineral waters of the country.[2] This includes a table of all mineral springs which yield more than 1000 gallons per hour; these number more than 120. Mineral springs are found to be usually associated with areas of sedimentary rock, particularly in the neighbourhood of mountain ranges, where they have suffered much disturbance, and where volcanic action is now, or recently has been, rife. The annexed classification is adopted:—

(A) Non-thermal.
(B) Thermal.
(1) Alkaline.
(2) Alkaline-saline.
(3) Saline.
(4) Acid.

Each of the four last divisions is again divided into sulphated and muriated, and the last into siliceous as well. It is recommended that, in future, analyses shall conform to the scheme laid down by the Chemical Society of Washington, the most important points in which seem to be that solids shall be expressed in parts per million, and that the radicles actually found shall be expressed; while the chemist is at liberty to express, in addition, the probable state of combination in which the different ingredients occur. A brief account is given of the various

[1] Thirteenth Annual Report of the United States' Geological Survey, 1891-92. (1893.)

[1] Fourteenth Annual Report of the United States' Geological Survey, 1892-93. (1894.) [2] *Ibid.*

purposes for which the more important waters are used, and two maps are appended; the second of these indicates the distribution of waters used commercially, and the first shows, as might be expected, the much wider dispersal of springs used as health resorts. A complete list of known springs closes the paper.

Mr. Merrill follows[1] with an account of the results of stream measurements. These are carried out by means of current meters, while the fluctuation of streams is recorded by nilometers. The "run-off" is expressed in second-feet (*i.e.* the water carried by a stream 1 foot wide and 1 foot deep flowing 1 foot per second), and the total discharge in acre-feet. The records have been continued monthly for many years, and yield a vast body of useful hydrographic information with regard to such rivers as the Missouri, Yellowstone, Rio Grande, Arkansas, Bear, and Snake Rivers. Curves are drawn where possible, and there are two maps, one delineating the rainfall of the States, and the other the run-off of the principal river basins. The latter quantity reaches a maximum in the eastern States, and at the southern end of the Rocky Mountains in Wyoming. Run-off is a function of rainfall and topography, with modifications introduced by other conditions, such as climate, structure, and vegetation; the ratio of run-off to rainfall is greater in mountain districts than in valleys.

A list of Californian earthquakes in 1893, by Mr. C. D. Perrine, is given in *Bulletin* 114.[2]

We have reserved till last the modestly told account of Mr. I. C. Russell's exploration of the Malaspina glacier, and his plucky attempt to reach the summit of Mount St. Elias.[3] Although unsuccessful he appears to have done enough to be able to point out a route which, with better luck and weather, will probably lead the way to this coveted point; and one cannot but hope that it may fall to the lot of this explorer to be the first climber to reach the top.

The Malaspina glacier is fed by all the southern and western ice-streams of the St. Elias range, which is but an outpost of a vast mountain area to the north. From the highest point which he reached, Russell saw this new land spread out before him like a map; but the point of view was not reached without much labour in the carrying of camp equipments, and in step-cutting up the great ice-falls. The glacier seems to be a great reservoir or sea of ice, stagnant or retreating, rather than a living and growing river of ice, and it deserves the term "piedmont glacier" bestowed on it by our author. It only pushes out into the sea at one point, Icy Cape, to the west, but elsewhere it is separated from the ocean by a belt of flat land of varying width. This border gave the same trouble to Russell's party that it has done to English explorers, on account of its icy-cold rivers and dismal swamps, somewhat mitigated in this case by the vast strawberry meadow in which the first camp was pitched.

Cutting a way through the great forest-belt, and pushing through the thick moraine at the margin of the ice, the party went across the glacier in the direction of the Chaix Hills, noting here and elsewhere the astonishing feature that the live moraine was often covered with a dense coat of vegetation, including trees of considerable age and size.

The Chaix Hills are made of stratified sands and clays containing marine shells, and some 4000 or 5000 feet in thickness; these deposits were evidently formed in the sea at the extremity of a glacier, and subsequently uplifted The uplift appears to have taken place along a line of fault extending from the Robinson Hills at the west, past the Chaix Hills, and on to the Samovar Hills and Pinnacle Pass at the east. Thence they pushed across the Agassiz and Newton glaciers, passing many ice-falls, the surface between which had a gentle and, even in some cases, a reversed slope. Capital descriptions of the scenery are often given, and numberless glacial observations recorded.

Although the party camped for twelve days at the entrance of the amphitheatre at the head of the Newton glacier, the weather only permitted of one advance during the time. They then reached an altitude of 14,500 feet on the col between the summit of Mount Newton and that of St. Elias; but here they found themselves forced to return, as they had not strength to accomplish the 6500 feet between themselves and the summit in addition to the labour of returning to camp that night. It was concluded that it would be necessary to camp on the col itself, when a final attempt of the peak was made. A second effort was made, but the avalanches and the dangerous condition of the snow compelled a speedy retreat, and, bad weather setting in, they were obliged to abandon the attempt, and confine themselves to investigations on the glacier at lower levels, and on its margin. They had, however, reached high enough to obtain a glorious panorama extending to Mount Fairweather, 200 miles away to the south-east, and to mountains of equal altitude and distance to the north-west. They looked to the north over a great "land of nunataks," a vast area of snow 8000 feet high, dominated by peaks rising yet 4000 feet higher.

The expedition then retreated down the glacier to where the Yahtse River emerges from its cavern of ice; thence they went along the shore to Yakutat Bay, exploring the edge of the ice on the way, and then they extended their survey along Disenchantment Bay, which, judging from the vivid description given, might well dispense with the first syllable of its name. It appears to be a charming region of mountains, glaciers, and bays, which may well in the future attract the notice of travellers and climbers in search of new ground.

The height of Mount St. Elias was determined, within a plus or minus error of 100 feet, as 18,100 feet. The work at the edge of the ice gave many useful results. The supremacy of the water action in the sea, and even in the rivers, soon made itself felt in the characters it induced on the material transported by the ice, but laid down in the water; the ice frequently traversed unconsolidated material without disturbing it, and ridges of gravel, very like kames and eskers, were found to have been deposited by glacial rivers when at a higher level than that at which they at present flow.

On the main mass of the glacier there are many new facts recorded; but we have room for only a few of them. Dykes of veins of hard ice, frozen in fissures, are added to the many structures in which ice resembles less transient rocks. A rough sorting of débris takes place on the ice surface as the rocks roll down the numerous irregularities, due to melting and other causes; moulins become filled with gravel when the water-action ceases, and then, becoming preserving causes, give rise to "sand cones," which recall the earth pillars of the Tyrol. In the stationary parts of the ice numerous lakelets of strange hour-glass-shaped section occur. Lakes of the same method of origin as the Märjelen Lake are frequent where the ice passes nunataks and valleys. The main drainage of the ice is englacial or subglacial, and surface streams are rare and evanescent. Finally, these streams tend to cut their channels upward through the ice as their floor gets coated with débris, which not only checks mechanical erosion, but is a bad conductor of heat. An immense amount of water-rolled material takes its place amongst the more truly glacial detritus, and it is somewhat noteworthy that nothing corresponding to *moraine profonde* is described by Mr. Russell in his report.

The strictly palæontological work in the period under

[1] Fourteenth Annual Report of the United States Geological Survey, 1892-93. (1894.)

[2] *Bulletin* 114, "Earthquakes in California in 1893," by C. D. Perrine. (1894.)

[3] Thirteenth Annual Report of the United States Geological Survey, 1891-92. (1893.)

review is rather scanty. It includes a short paper on the American Tertiary Aphidæ, by Mr. Scudder.[1] This comprises a list of known species and five plates. A monograph, by the same author, on the Tertiary *Rhynchophorous Coleoptera*[2] contains descriptions and figures of a great number of new genera and species, 193 species having been found in the older American Tertiaries, while only 150 species have been described from the whole of the European Tertiary rocks. This makes a first instalment towards a history of fossil Coleoptera.

Mr. Whitfield has written a description of the mollusca and crustacea of the Miocene formation of New Jersey.[3] This work, which is illustrated by twenty-four plates, describes the only brachiopod and cirripede found in these beds, with a large number of gasteropoda and lamelli-branchiata, many of which are now described for the first time.

Mr. C. R. Keyes gives, in *Bulletin* 121,[4] a bibliography of North American Palæontology 1888-1892. This comprises 251 pages, and in an alphabetical series are included a list of names of authors, with a short synopsis of essential points, including lists of genera and species described and figured, a title-index, and subject entries and cross references. A list of subjects is given in the introduction, and also a list of works examined, which may save a good deal of trouble. The list is by no means perfect, but it is undoubtedly a most important contribution to bibliography.

In a subsequent article it is proposed to deal with researches in petrological, dynamical, and stratigraphical geography.

OSTWALD'S ENERGETICS.

IN the February number of *Science Progress* there is an interesting article, by Prof. Ostwald, on "Emancipation from Scientific Materialism." There are so many vague fallacies underlying it, that it would hardly be worth answering, only that there is considerable risk that others, chemists especially, may be carried away by the arguments of one whom they rightly value as a leader in their own domain when he descants positively about the realm of mechanics.

Prof. Ostwald begins by saying that the current view of a mechanical universe fails in two respects. (1) It does not fulfil the purpose for which it was designed, and (2) it is inconsistent with known truths. It is, in the first place, to be remarked that nobody who has considered the matter really seriously can maintain that atoms and motion must constitute the whole universe. Such a view leaves thought out of account, and all that can be held is that material phenomena are so explicable. Prof. Ostwald ignores such theories as that of vortex atoms, which postulate only a continuous liquid in motion; but, it may be, this is omitted because it is merely a way of explaining the atoms. He also ignores metaphysical questions, such as whether motion be not only the objective aspect of thought, and also whether an intuitively necessary explanation of the laws as distinct from the origin and consequent arrangement of phenomena is not postulated by the fact that the universe must be intelligible. Consequently his attempt to deal with nature in a purely inductive spirit is unphilosophical as well as unscientific. The view of science which he puts forward—a sort of well-arranged catalogue of facts without any hypotheses—is worthy of a German who plods by habit and instinct. A Briton wants emotion—something to raise enthusiasm, something with a human interest. He is not content with dry catalogues; he must have a theory of gravitation, a hypothesis of natural selection. This deadly science without hypothesis is far worse than the materialistic *ignorabimus* of Du Bois Reymond; it is the culmination of the pessimism of Schopenhauer.

Prof. Ostwald's first line of attack is that the materialistic hypothesis does not fulfil the purpose for which it was designed. When this is investigated, it turns out that all he means is that everything in nature has not yet been explained on mechanical principles. And long may it be so. The zest of science is discovery. If everything were explained—well, it is so far off we may wait till it comes to describe what will happen. He notices several things which are certainly not explained yet. Such, for instance, as why when atoms combine they produce a result so very different from their components. As nobody has yet suggested any reason why the atoms themselves possess the very curious properties they do, we can hardly expect a satisfactory explanation of why these properties change when they combine. Any way, the existence of an uninvestigated region of this kind does not create any reasonable doubt as to the foundations of the road that has led us well so far.

His second attack is deliberately founded on this, that mechanical hypotheses have not yet been found to explain everything. "I grant," he says, "that for many individual phenomena the mechanical analogues have been given with more or less success. But all attempts to completely represent the whole of the known facts in any department by means of some such mechanical analogue have resulted without exception in some unexplainable contradiction between what really happens and what we should expect from our mechanical model. This contradiction may long remain hidden; but the history of science teaches us that it sooner or later makes its inevitable appearance, and that all we can say with complete certainty regarding such mechanical similes or analogues—usually termed mechanical theories of the phenomena in question—is that they will doubtless on some occasion fail."

All that this really means is that we have not yet explained everything on mechanical principles, and that when we do get a little way on, we are delayed again by something more that requires explanation. But surely this and nothing else is what we ought in all reason to expect. It is about the best test we have that we are on the right track. Prof. Ostwald cites optical theories as an example of the kind of failure he refers to. He seems for some extraordinary reason to imagine that the *elastic solid* theory of the ether is in some curious way specially connected with the mechanical hypothesis of the universe. It is far from being so. The mechanical theory of an elastic solid itself has been only very dimly foreshadowed, and Prof. Ostwald's contention that transverse vibration "presupposes a solid body" is in direct contradiction to Lord Kelvin's theorem that a liquid in turbulent motion could transmit transverse vibrations. Even Lord Kelvin's elastic solid ether in a state of tension could exist if it be infinite, so that here again Prof. Ostwald is mistaken in saying that, because it could not be stable if finite, it can have no physical existence. And finally Prof. Ostwald takes refuge in the as yet unexplained constitution of an ether whose properties were discovered by assuming them to be mechanical, and were only discovered about thirty years ago, and have not been seriously investigated until within the last ten years. Surely no argument can be based upon the fact that there are limits to our present knowledge.

Prof. Ostwald's third attack opens out a new view. We see here a human reason for his desire for emancipation from the mechanical hypothesis. He is dissatisfied with Du Bois Reymond's *ignorabimus*. But even Du Bois

[1] Thirteenth Annual Report of the United States Geological Survey, 1891-92. (1893.)
[2] *Monograph* xxi., "The Tertiary *Rhyncophorous Coleoptera* of North America." By Samuel Hubbard Scudder. (1893.)
[3] Monographs of the Geological Survey of the United States, vol. xxiv. (1894.)
[4] *Bulletin* 121, "A Bibliography of North American Palæontology, 1888-1892," by C. R. Keyes. (1894.)

Reymond is not infallible, and most prophecies as to the limits of human knowledge have turned out to be only limits to the ingenuity of the prophet. It is very much more likely that Du Bois Reymond's apparently resistless logic has a flaw, than that the path of progress of science for three hundred years has been along the wrong route. There are plenty of philosophical speculations, which no doubt Du Bois Reymond brushes aside as hardly worth consideration, which would entirely invalidate the greater part of his arguments. Even though they do not, it is certainly quite unscientific to leave a road that has led to great discoveries merely because you imagine that there is some curious spectre in the distance to which you think it is leading you.

Prof. Ostwald's fourth attack is based on the fact that seeds grow into trees, but that trees do not grow back again into seeds. He thinks that if the universe were a mechanical system, there is no more reason for one than the other, and that they should occur equally often. As he says, "the tree could return again to the sapling, &c." But that is not the question. The question is, *must* it, if this is a mechanical universe. The order of events depends entirely, in a mechanical universe, upon the *initial conditions*, and all we can say is that the initial conditions of this earth were such that trees generally grow from seeds, and that the reverse operation has never been known to occur. That it *has* never occurred has nothing on earth to say to the question of whether this is a mechanical universe. As a matter of fact, I believe that this and other much simpler cases, such as are usually classed under irreversible actions in thermodynamics, can be shown to be not only, as I have here argued, *possible* mechanical processes, but to be *the most probable* mechanical processes. Hence it is quite possible that the actual sequence of events which Prof. Ostwald cites as disproving the mechanical theory of the universe may be the very best proof extant, not only that the mechanical theory is the most probable theory, but it may even lead us to conclude that it is the only possible theory.

Finally, Prof. Ostwald tries to build up something instead of what he thinks he has demolished. A vague energetics is what he presents instead of the mechanics of the past. He advocates the deadly view that science should be a catalogue, well arranged, no doubt, but free from those dreadful hypotheses. He prefers volume energy to the molecular theory of gases. He criticises this latter by neglecting to see that the quantity often quoted as energy per cubic centimetre of the gas is really momentum per second carried across a plane, and has consequently that very element of direction which he accuses it of not possessing, and the absence of which in volume energy one might possibly expect him to explain. Prof. Ostwald's idea of science as free from hypothesis is the most advanced form of pure positivism. If he were consistent, he should deny the existence of thought in the moving coloured, soft, objects he sees and feels around him, and calls men. That other men think is a hypothesis; and if he rejects all hypotheses, why not this?

In conclusion, Prof. Ostwald seems to have some dim doubt whether energetics will explain everything. As the doctrine of the conservation of energy will not determine by itself the motion of even a single planet round the sun, it is somewhat curious to see the doubt that seems to haunt him in answering this question. The doctrine of the conservation of energy is most valuable, but it goes only a very little way in explaining phenomena. More than energetics is certainly required unless we are prepared to endow energy with all sorts of curious properties after the manner of our predecessors, who used to invent a new subtle fluid with convenient properties in order to explain every new difficulty. Prof. Ostwald's energy seems more like one of these subtle fluids than any product of modern thought.

GEO. FRAS. FITZGERALD.

THE HIGHLANDS OF PERU.[1]

THE two first volumes of this work were noticed in NATURE, vol. li. p. 388, and the general remarks made there apply in great measure to the new volume also. We must, however, observe that the highlands of Peru afford material for a much more interesting description than the coast and the capital, which were dealt with in somewhat wearisome detail. Here the narrative form is not unwelcome, for there is always a charm in the

The Andes from Chililaya, Lake Titicaca

[1] "Beobachtungen und Studien über das Land und seine Bewohner während eines 25-jährigen Aufenthalts." III. Band. Das Hochland von Peru. Von E. W. Middendorf. Pp. 604. (Berlin: Robert Oppenheim [Gustav Schmidt], 1895.)

record of travel in the Cordillera, even upon the beaten tracks.

A short general introduction gives some account of the Andes as a whole, with remarks on the characteristic scenery, on the roads, the methods of travelling, and a few pages on the vegetation. Then follows the description of a series of four journeys through different parts of highland Peru, with observations drawn from official sources regarding some places not personally visited, such as the Amazon territories and the Bolivian coasts of Lake Titicaca. The first journey led over the Cordillera Negra and the Cordillera Blanca in Central Peru to Huanuco and the famous mining town of Cerro de Pasco, 4350 metres in elevation, with great silver-mines tunnelled into the mountains. The best room of the best hotel in this loftiest town in the world was found in such a condition that Dr. Middendorf could not say whether its floor was of tiles, mud, or boards, and he hailed the invitation of the Scotch engineer in charge of the mines as a happy deliverance.

The second journey was in the northern part of the republic, from the seaport of Pacasmayo by Cajamarca to the Maranon valley and Chachapoyas, returning across the Cordillera by Huanachuco to Trujilla. A short account of the Amazon province of Loreto is added, and an historical narrative of the discovery and exploration of the Amazon.

The third journey was a visit to the great plateau-lake of Titicaca, with many particulars regarding the ancient ruins of the Inca time. The concluding section, on the mountains of Southern Peru, describes the return journey down the long valley to Cuzco, and thence over the Cordillera past Ayacucho to Lima.

Throughout the work there are happy descriptions of the native peoples, the scenery, and the incidents of the journey. Dr. Middendorf seems to have paid considerable attention to linguistic studies, and also to the architecture of the ancient ruins. He especially remarks the contrast between the mud-huts, or dwellings built of sun-dried bricks, which characterise the arid coast-strip, and the megalithic masonry of the lofty plateaus and high mountain valleys.

The illustrations throughout are extremely well chosen, really illustrative of the natural features of the great Cordillera, and they are numerous enough to satisfy the most exacting. An index to all three volumes completes the work.

SEKIYA SEIKEI.

ALL students of seismology and vulcanology will learn with regret that Prof. Sekiya has passed from amongst us. He was born towards the end of 1855, a year well remembered by the inhabitants of Yedo as that of the great earthquake. In 1876, whilst on a visit to England to complete his studies as a mechanical engineer, he fell a victim to consumption, the symptoms of which gradually grew more and more severe until January 9 of this year, when they culminated in his death.

After acting as assistant to Prof. J. A. Ewing, in 1886 he was appointed to the newly-created chair of Seismology at the Imperial University of Japan.

A lasting testimony to his ingenuity and perseverance, which is to be seen in many museums, is a model illustrating the path followed by an earth particle at the time of an earthquake. Although he wrote much in Japanese, he contributed many valuable papers and memoirs in English or French to the journal issued by his own college, to the *Transactions* of the Seismological Society, and to other periodicals.

The impetus he gave to seismology by the enlargement of the University Laboratory, the establishment of instruments throughout Japan, and to the extension of the seismic survey of that country, which now boasts of 968 stations, is well known to his colleagues and acquaintances. Sekiya was a kind and sincere friend, and his honesty and unflinching straightforwardness of speech were a by-word amongst all who knew him. J. M.

NOTES.

PROF. J. J. SYLVESTER, F.R.S., has, with the approval of his Majesty the King of Italy, been elected a Foreign Member of the Royal Academy of Sciences of Turin.

A NUMBER of admirers of Prof. Mittag-Leffler, the founder of the *Acta Mathematica*, will shortly present him with a congratulatory address, written in four languages—German, French, Italian, and English—and expressing the appreciation of mathematicians of the services he has rendered to their science. It is proposed to present him at the same time with his portrait in oils, and a subscription list has been opened to obtain funds for that purpose. Prof. Appell, 6 rue Le Verrier, Paris, will be glad to receive subscriptions.

SIR J. RUSSELL REYNOLDS has expressed his intention to retire shortly from the Presidency of the Royal College of Physicians.

THE Chairman of the Local Committee for the Toronto meeting of the British Association for the Advancement of Science is Dr. A. B. Macallum.

AT the ordinary meeting of the Royal Meteorological Society, on Wednesday next, a lecture will be given by Mr. Frederic Gaster, on "Weather Forecasts and Storm Warnings, how they are prepared and made known."

A LIVE gorilla, said to be the largest ever imported into this country, has just been received at the Zoological Gardens, Regent's Park. The animal comes from near Ngove or Iquela, on the French Congo, and is in excellent health.

THE De Morgan medal, which is given triennially by the London Mathematical Society, will be awarded in June next, and nominations may be made at either the March or April meetings of the Society. Prof. Klein, of Göttingen, editor of the *Mathematische Annalen*, was the last recipient.

THE Paris correspondent of the *Times* states that a tablet commemorating Franklin's residence at Passy, then a village outside Paris, was unveiled on Sunday in the wall of the Christian Brothers' School, Rue Raynouard. M. Faye, of the Academy of Sciences, and M. Guillois, a local antiquary, delivered addresses.

SIR W. M. CONWAY proposes to take a party to Spitzbergen next summer, for the purpose of exploring the interior. He expects to be accompanied by Mr. Trevor-Battye, and by four others, all of them scientific experts in different branches, so that the journey may result in valuable increase to scientific knowledge.

WE regret to announce the deaths of Mr. James Abernethy, past-President of the Institution of Civil Engineers, and a Fellow of the Royal Society of Edinburgh; Dr. Alfred D. Kennedy, a distinguished chemist and toxicologist, of Philadelphia; Dr. H. Ernest Goodman, Professor of Surgery in the Medico-Chirurgical College, Philadelphia; Dr. R. M. Hodges, Professor of Surgery at Harvard; and Christophe Negri, the Italian economist and geographer.

THE second International Horticultural Exhibition will be held at Dresden, from May 2 to 10 next, under the patronage of

the King of Saxony. Prizes will be awarded for exhibits of flowers and plants, cut flowers, arrangements of flowers for decorative purposes, plans of gardens and greenhouses, garden buildings, heating appliances, and other horticultural requisites. Applications for space to exhibit flowers and fruit, as well as for forms of entry and programmes of the exhibition, must be made, not later than April 10, to the "Geschäftsamt der II. Internationalen Gartenbau-Austellung, Dresden."

HERR ANDRÉE'S balloon for his polar expedition is taking shape. The upper half is already sewn together, and the parts of the lower half are cut out. The Société Nordenfelt, who desired that this trust might be given to them, are superintending and controlling the work on the balloon. Arrangements have been made with the builder, Mr. F. O. Peterson, in Gothenburg, to construct a balloon house, to be ready by May 25, and two competent men, who are assisting in the construction, will go to Spitzbergen to erect the house. The *Virgo*, the steamer in which the aeronauts will set out for Spitzbergen, will carry about thirty-five tons of sulphuric acid to generate the hydrogen. Great interest is felt in the enterprise all over Sweden.

IN the House of Commons on Tuesday, for the first time since the question of the opening of museums and galleries was raised in Parliament, a majority was obtained in its favour. Mr. Massey-Mainwaring's motion was:—"That, in the opinion of this House, it is desirable that the national museums and art galleries in London should be open for a limited number of hours on Sundays, after 2 p.m., upon condition that no officer shall be required to attend on more than six days per week, and that any who may have conscientious objections shall be exempt from Sunday duty." On a division, an amendment to the resolution was rejected by 178 votes against 93, and the resolution was then agreed to. It only remains now for the Government, and the Trustees of the British Museum, to put the resolution into effect.

THE Lord Mayor presided on Friday, at the Mansion House, over a meeting held for the purpose of discussing the arrangements for the International Horse and Horseless Carriage and Roads Locomotion Exhibition, which it is proposed to open at the Crystal Palace in May next. Mr. A. Sennett was elected honorary executive commissioner, and executive committees for horse-drawn and mechanically-propelled vehicles respectively were appointed, the members including Sir Frederick Bramwell, Sir Douglas Galton, Sir H. Trueman Wood, Prof. Boys, Sir David Salomons, Mr. G. N. Hooper, Mr. Jacobs, Mr. W. Warby Beaumont, and Mr. E. Macrory, Q.C. It was announced by Sir David Salomons, who occupied the chair during the latter part of the proceedings, that Lord Kelvin had consented to join the honorary Council.

WE learn through the *Engineer* that the management of the *Cosmopolitan*, a monthly magazine, is offering £600 in premiums to be awarded to horseless carriages presenting the greatest number of points of excellence, as exhibited in a trial trip to be made on May 30. This trip will be from the City Hall Park, in New York, to Irvington and back, a total distance of 52 miles. The award will be made upon the following points, the maximum aggregate being 100:—Speed, 50; simplicity and durability of construction, 25; ease in operating, and safety, 15; cost, 10. The route will be along Broadway, through Central Park and over the Washington Bridge, thence along the main road to Yonkers, where the course will include five miles of asphalt paving, and then on to Irvington, on the Hudson River, 26 miles. There is a good road for the entire distance.

A BRIGHT aurora was seen at Worcester and other places on Wednesday, March 4. Mr. Lloyd Bozward says that at 7.30 on that evening "a remarkable beam of white light of dazzling brilliancy, far exceeding anything of the kind of recent years, arose from a point in the north-west, extending to the zenith, and spreading out fan-like in rising. So rare have been the appearances of the aurora here of late, and so startling the radiant effulgence, that many persons attributed the beam to the effect of an electric search-light."

A DISCOVERY of much interest has, says *Science*, recently been made in Western Kansas of an extinct species of Bison, the skull having an expanse of nearly four feet. Embedded below the humerus of the skeleton was a small but perfectly formed arrow-head. The Bison has not yet been identified with certainty, but seems closely allied to *B. antiquus*, though evidently larger. The formation is apparently the same as that which yielded the skeletons of Platygonus, recently obtained by the University of Kansas. The Bison skeleton, that of a bull, will shortly be mounted in the University museum.

THOUGH the coral rock in the northern part of the island of Ceylon has long been used in many departments of building, the *Ceylon Observer* thinks that builders do not avail themselves of the material so fully as they might. The stone is admirably suited by its lightness and toughness of texture for use as arch stones, being very readily shaped by an ordinary saw. Several long arched bridges have been built with it in the Jaffna Peninsula, and have proved its great durability as a building stone. It has also been applied to ornamental uses, the dressings and Gothic windows of St. John's Church at Chundikuli having been constructed of it. Cut into slabs, it has furnished the covering for nearly all the road drainage of the same locality. It is suggested that much employment could be economically found for this rock in the southern districts of Ceylon, its extreme lightness favouring the cost of freightage.

THE effect of African grass-fires in changing the aspect of the vegetation, forms the subject of a short paper by Mr. Scott-Elliot in the current number of *Science Progress*. Owing to the annual clearing of the ground by these fires, there is no accumulation of leaf-mould and stems, and the soil therefore never becomes improved. The season of flowering for many trees and herbaceous plants is completely altered, a large number of the latter sending up flowering stems, entirely without leaves, after the first shower of the rainy season; and the stems only begin to produce leaves when the rains have well set in. Another curious effect of the fires is the manner in which trees are either kept down or obliged to protect themselves in some way against their action. Of the trees which do manage to exist in spite of the annual conflagration, the most remarkable are the tree Euphorbias, which seem to come out of the most violent fire with only a few scorched branches. Mr. Scott-Elliot brought home with him several specimens of the bark of the six or seven forms of trees which manage to survive the ordeal by fire, and an examination of them led Prof. Farmer to conclude "they all agree in possessing cells which show a certain amount of gummy degeneration of the cells in the bark, together with the presence of a considerable amount of sclerotic cells; it seems not impossible that these two facts may be connected with the resistance of the plants to the fires."

AN ambitious scheme, but, at the same time, one which deserves the careful consideration and full support of all British geographers, was laid before a technical meeting of the Royal Geographical Society, held last Friday, by Dr. H. R. Mill. Dr. Mill proposes that a complete geographical description of the British Islands should be prepared from existing data, supplemented to a small extent by new researches and by the collection of unpublished information. This should be done on a uniform scale for every small selected unit of the country; then combined into a series of regional memoirs dealing with natural

districts; and ultimately the whole would be generalised into one memoir on the whole country, the result of a series of generalisations carried out much in the same way as the various maps of the Ordnance Survey are obtained by successive generalisations from the largest scale produced. The chief sources of information would be the topographical map of the Ordnance Survey, the maps of the Geological Survey, the charts of the Hydrographic Department, the publications of the Meteorological Office, the Census reports, the reports of the Board of Trade and other Government departments, the publications of such societies as the Royal Agricultural, the Archæological, the Statistical, the Institution of Civil Engineers, and many others, and the pictures of amateur photographic societies. Dr. Mill explained in detail the plan of the proposed memoir, and the method in which it should be carried out. After a discussion, Mr. Clements Markham, who occupied the chair, said he should certainly recommend to the Council that the memoir be prepared under the Society's auspices. The practical problem of expense has, however, to be solved before the plan can be developed.

An important contribution to the knowledge of the origin and movement of sand, shingle, and alluvial matter around our coasts, was made by Mr. W. H. Wheeler at the meeting of the Institution of Civil Engineers last week. It appears that the generally accepted theory, that the travel of drift along a coast is due to and is in the direction of the prevailing wind, is contrary to fact. In England the prevailing winds are from the south-west; whereas the travel of drift on the east coast is southward, on the south coast from the westward, and on the west coast northward, in each case being in the same direction as the flood tide. Mr. Wheeler has been unable to find a single instance where the regular and continuous travel of drift along a coast is in the opposite direction to that of the flood tide. While winds and waves are the agents which operate in eroding cliffs and producing the supply of drift, the continuous progressive movement of sand and shingle along the sea coast is caused by the wave action of the flood tide, which is increased when the wind blows in the same direction as the flood tide. With regard to alluvial matter in estuaries, this is derived from detritus brought down by rivers, and does not come from the sea, nor is it supplied from the waste of clay or chalk cliffs along the sea coast. The only current along the coasts of England which can transport material in suspension is that due to the tidal wave, which travels each way for about six hours at the rate of between 2 knots and 2½ knots. It is known that the material in suspension is not carried upwards for any great distance above the mouth of a river or estuary. The tidal wave propagated up a river creates only an oscillating current, and the same quantity of tidal water which goes up returns on the ebb, with the addition of the current produced by the fresh water; the tendency of movement is, therefore, downward, and not upward. Mr. Wheeler applied these and other facts to determining the principles which are essential in the construction of harbours on shingly or sandy coasts.

The current number of the *Comptes rendus* (March 2) contains a paper by M. Henri Becquerel, on some invisible radiation emitted by phosphorescent bodies. In some previous experiments the author has shown that phosphorescent bodies give out radiation which is capable of traversing bodies which are opaque to ordinary light rays. The great interest at present shown in this subject has induced him to give an account of a number of recent experiments. The phosphorescent bodies employed have been crystals of the double sulphate of uranium and potassium. The phosphorescence of this body is very marked, but only lasts, as far as the rays which affect the eye are concerned, at any rate, for less than one-hundredth of a second. It can easily be shown that the rays emitted by this body when exposed to diffused daylight or to direct sunlight are capable of traversing not only black paper, but also aluminium and thin sheets of copper. For if an ordinary dry photographic plate, enclosed in a tin-plate slide with an aluminium window, is exposed to sunlight even for a whole day, the plate is unaffected. If, however, a crystal of the uranium salt is placed on the aluminium window, and the whole is exposed to sunlight for a few hours, then on developing the plate a shadow of the crystal will appear in black. If a thin plate of copper, cut into the form of a cross, is placed between the crystal and the aluminium window, a clear image of this cross is formed on the plate. The curious result has, however, been obtained that although the plate-holder and the uranium salt are not exposed to the light, but kept inside a wooden or cardboard box, the photographic plate shows the same images as when the salt is exposed to light. The author rather tentatively suggests that the uranium salt may continue to emit by phosphorescence radiation that is invisible to the eye, but which is capable of traversing paper and aluminium for a time infinitely great compared with the time during which it continues to emit visible rays.

The February number of the *Journal de Physique* contains a paper, by M. C. Limb, on the determination of the electromotive force of a Clark cell in absolute measure. Instead of adopting the usual method, which is to compare the difference of potential at the ends of a known resistance when traversed by a known current with that of the cell, the author has adopted a novel method which is independent of the units of current and resistance. A magnet is rotated inside a long helix about an axis perpendicular both to its own magnetic axis and the axis of the coil. The magnetic moment of the magnet is determined by Gauss's method. If H is the field which would be produced at the centre of the long coil if the spirals were traversed by unit current, ω the angular velocity of the magnet and M its magnetic moment, then the maximum value of the electromotive force induced in the coil will be $HM\omega$. A correction has to be applied on account of the finite length of the coil which involves the distance between the poles of the magnet. The angular velocity is measured by simultaneously registering the turns made by the magnet and the beats of a seconds pendulum, the velocity being maintained constant by a specially designed tachyometer. By means of a commutator fixed to the axle of the magnet, the circuit of the coil is only closed at the moment when the induced electromotive force is a maximum. This maximum electromotive force is compared with that of the cell by means of a modified form of Clark potentiometer, a Lippmann capillary electrometer being employed to indicate when the balance is secured. This electrometer is capable of indicating a difference of potential of 0·00005 volt. The Clark cell was of the H pattern, and the author gives as his final result for the electromotive force of this form of cell at 0° C. the number 1·4535. The number obtained by Lord Rayleigh was 1·4527 volts.

The habit of opium-smoking forms the subject of a paper, by M. H. Moissan, in the *Annales de Chimie et Physique*. M. Moissan finds that the Chinese do not smoke crude opium, but a preparation of it called *Chandu*, which, when heated to about 250° produces a smoke formed of volatile perfumes and a small quantity of morphine; this appears to produce no more ill-effects than tobacco-smoking. The commercial quality of opium, however, is very different; the residues that remain after opium-smoking are sold as dross, and when this is treated to a temperature of 300° to 325° various toxic compounds are given off.

We have received, from Mr. E. Kayser, a pamphlet containing a considerable number of measurements of cloud-heights taken at Dantzig last summer. The observations were taken

by various kinds of instruments, but the principle was the same throughout—viz. two corresponding stations of known base were selected, and the apparatus directed at the same instant on the same point of the sky. A full description of the instruments and method is given in the text, and printed in vol. ix. of the *Schriften* of the Dantzig Philosophical Society. The publication of the work is timely, as on May 1 next a year of special cloud observation in all parts of the world is to commence, under the auspices of the International Meteorological Committee. The pamphlet contains much useful information for intending observers.

The *Verhandlungen* of the German Geographical Society (No. 1, 1896) contain a lecture, by Mr. A. Berson, on the use of balloons for geographical purposes. As Mr. Berson has made many ascents, both in free and captive balloons, in connection with the Berlin Meteorological Office and other German institutions, his remarks possess considerable interest. He refers to the importance of captive balloons in voyages and in Arctic expeditions, and regrets that Dr. Nansen did not take one with him as he originally intended. He strongly condemns the proposal to use a free balloon in the Andrée polar expedition, and thinks it must certainly end in disaster. Mr. Berson found during his ascents that in all types of weather, and at all seasons, the temperature at great heights decreases more rapidly, or at least as quickly, as in lower altitudes, and that at a height of over 5000 metres much lower temperatures exist than those assumed after Mr. Glaisher's ascents. Also that the increase of wind velocity is much greater than was supposed; in one ascent, when the wind velocity was only about seven miles an hour at a height of between 1000 and 3000 metres, it reached thirty-seven miles an hour, between 4000 and 6000 metres. A preponderance of winds with westerly components was also observed in great altitudes, as is shown by cloud observations made at the earth's surface.

Dr. C. Sapper has studied the customs and religious views of the Kekchi Indians of Guatemala (*Internat. Arch. f. Ethnogr.*, viii. p. 195), and it is interesting to trace the Pagan-Christian overlap in the religion of these professed Roman Catholics. They will not worship in a church out of their own district, as they believe that the god of that church cannot understand them; indeed, when they go to neighbouring places, they renounce all religious exercises. Crosses are erected on mountain-passes by all the Maya Indians, and a native on first crossing a pass puts a stone at the foot of a cross, and often offers flowers and incense, and sometimes he will dance before it. If there is no cross on a pass, the Kekchi Indian prays and brings offerings to the heathen god. In order to make green parrots tender—for they are very tough—the natives put them in a hammock before cooking, and rock them, whistling to them, as if they were sleepy children. Money presents, formerly to the value of 2½ dollars, were paid by the bridegroom's father to the bride's father, but the price has now risen to 7 dollars. A girl can have a husband bought for her, but it is more expensive, as he costs 10 dollars.

In the same journal (p. 215), Dr. J. Walter Fewkes gives a "Provisional List of Annual Ceremonies at Walpi," his idea being to bring together in proper sequence the prescribed yearly observances of the Tusayan Indians. It appears that the dates for the various festivals and ceremonies were fixed by the extreme summer and winter solstitial points of risings and settings, and by certain hillocks, notches, or trees on the horizon. When the sun appears to rise or set behind recognised definite points on the horizon, certain religious ceremonies are announced, and secular occupations, as that of planting, initiated. The author briefly describes the various annual ceremonies, the period of their commencing, and their duration. It will be evident that this is an important paper, as it coordinates previous observations.

Until Busse last year proclaimed the existence of a species of yeast possessing pathogenic properties, this class of microbes had escaped all imputation as regards disease-producing characteristics. Busse's researches have been followed up by others from Colpe, and Sanfelice, but the latest contribution to the subject has been received from Dr. Lydia Rabinowitsch, who has worked at it under the superintendence of Dr. Robert Koch at Berlin. Fifty different varieties of yeast were collected, and out of these, seven were found possessing pathogenic properties. These yeasts appear to be distinct from those pathogenic varieties isolated by other observers. Amongst them is *Monilia candida*, a yeast already investigated by Jörgensen, and of considerable interest on account of its remarkable fermentative properties, but which Dr. Rabinowitsch found was fatal to both rabbits and mice, although guinea-pigs were in no way affected by it. Another yeast, pathogenic to mice, was obtained from some figs which had been allowed to ferment, whilst a so-called "wild" yeast, found on grapes, killed both rabbits and mice. A variety of yeast isolated by Prof. Delbrück from ale, and sent from America, was also found to be fatal to rabbits in from nine to ten days, and to mice in from four to six days when subcutaneously introduced. The fact that these pathogenic yeast cells were usually found abundantly present in the blood, and in the various organs of the animals' bodies, justifies, says Dr. Rabinowitsch, the assumption that the effect produced by them was not due to intoxication from the products elaborated by them, but to direct infection through their copious multiplication within the animals' system. Sanfelice's observation that the yeast cells presented a different appearance when taken from artificial cultures, and from the bodies of animals respectively, was not confirmed by Dr. Rabinowitsch, who could detect no difference.

Among the excursions which the Geologists' Association are arranging for the coming season, the farthest afield are those to the Dorsetshire coast (Easter), Chippenham and Calne (Whitsuntide), Ipswich, the new railway at Catesby (Northants), and West Somerset and North Devon (in July). Nearer town, Galley Hill (Kent), Hendon, Leith Hill, Chingford, Reading, Hitchin, and High Barnet will be visited.

The present volume (vol. xiv.) of the *Proceedings* of the Geologists' Association will be largely devoted to Indian geology. The two presidential addresses of the late President, Lieut.-General C. A. McMahon—the first published in the number for May 1895, the second not yet published—deal with the Himalayas. The February number, which has only just been issued, contains a paper, by W. H. Hudleston, on the geology of India in general, with special notes on a journey from Bombay to Kashmir. The first part gives an excellent summary of the geology of India, illustrated by a coloured map; while a number of sections accompany the second part.

The monthly notes on Petrography, contributed by Dr. W. S. Bayley to the *American Naturalist* for 1895, have been reprinted and issued together as a "Summary of Progress in Petrography," which should be welcomed by those who are unable to keep themselves abreast of the rapid increase of knowledge in this department. A subject- and an author-index are added. As the author omits his own papers, with one exception, from the list, we may add that his researches on the Basic Massive Rocks of the Lake Superior region, published in the Chicago *Journal of Geology*, should not be overlooked by students of Petrography.

An order has been made by the Home Secretary, which prohibits the taking or destroying of the eggs of the following species of wild birds throughout the administrative county of Durham:—

Blackheaded gull, common buzzard, kestrel, merlin, owls (all species), bittern, curlew, dipper, dotterel, dunlin, golden plover, goldfinch, heron, hawfinch, kingfisher, martins (all species), nightjar, nuthatch, pied flycatcher, peregrine falcon, raven, ring ouzel, snipe, swallow, treecreeper, water rail, wagtails, woodpeckers (all species), woodcock. It is also ordered that the Wild Birds Protection Act, 1880, shall apply throughout the county of Durham to the following species of wild birds:—Bearded tit, buzzards (all species), hobby, kestrel, martins (all species), merlin, osprey, peregrine falcon, swallow, swift, wryneck.

IN the *Entomologist's Monthly Magazine* for March, Dr. T. A. Chapman records an experiment on the artificial prolongation of the larval stage in Lepidoptera, which, although brief and incomplete, indicates an important line of research in connection with metamorphosis. Caterpillars of *Agrotis comes*, on reaching the last normal stadium, were starved so as to delay growth, and after six weeks were then placed on abundant diet. Some died, several turned normally to pupæ, and others endeavoured to prolong the larval condition. Two alone succeeded, and assumed a further larval instar, accompanied by modifications in the antennæ, maxillæ, legs and eyes. Those which failed were shown by dissection to be endeavouring to accomplish similar changes. In this way an aberrant larva, with certain pupal or imaginal characteristics, was obtained. These experiments have some analogy with the production by Grassi of intermediates between the normal forms found in a nest of Termites, and perhaps with certain phenomena of hypermetamorphosis. Further and more complete experiments will be awaited with interest.

CREMATION as a means of disposal of the dead is steadily gaining favour. From the report of the Council of the Cremation Society for 1895, we see that 150 cremations were carried out at Woking during the year, and fifty-eight at Manchester. When the Society commenced operations in 1885, only three bodies were cremated, but this number has continuously increased since that year. At the present time, the crematorium at Manchester is the only one in operation in England besides the one at Woking. Another is, however, being erected near Liverpool, and will shortly be opened for use; and last November, a building, comprising a crematorium, chapel, and waiting-rooms, situated on the outskirts of Glasgow, was opened by Sir Charles Cameron.

WE have on our table the sixth edition of M. P. Schützenberger's well-known work on "Les Fermentations," published by M. Félix Alcan in the comprehensive Bibliothèque Scientifigue Internationale. The whole of the text has been revised, and numerous additions have been made. The "Résultats de l'examen de dix mille observations de hernies," communicated to the last French Congress of Surgery, by Prof. Paul Berger, has been published in volume form by M. Félix Alcan. Mr. Ernest Hart's criticism of "Hypnotism, Mesmerism, and the New Witchcraft" (Smith, Elder, and Co.) has blossomed into a second edition. A chapter has been added, embodying the confessions of a professional medium, and some new matter has been placed in an appendix, but no other changes have been made.

A NEW monthly magazine—the *Ornithologist*, edited by Mr. H. K. Swann—has just appeared, its claim to distinction among the periodical literature of natural history being that it is the only monthly journal of ornithology published in the British Islands, though there are several which devote a large share of their space to the subject. The first number of the new publication contains, among other contributions, notes on birds seen during a continental tour, by Mr. O. V. Alpin, notes on the nesting habits of the oyster-catcher, by Mr. F. B. Whitlock, and on British birds at Wiesbaden, by Mr. Graham W. Kerr. There is also a full-page plate showing the nest of a wheat-ear, built in an old tin can, and a portrait of the late Mr. Seebohm. We welcome this addition to the ranks of scientific journals, and hope that it will long live to encourage observation and research.

THE recent discovery of argon in atmospheric air, by Lord Rayleigh and Prof. Ramsay, aroused such great interest, that it has been resolved, on the repeated request of the "general public," to prepare a volume containing an account of the methods of extracting the new gas from air, and of its properties, explaining, where necessary, in popular language, the basis of the reasoning employed in drawing conclusions relative to argon. But the whole history of the determination of the gases in air is so closely related to this recent discovery, that it would hardly have been possible to present the subject in its entirety without a preliminary sketch of the discoverers and their work. The little work, which has been written by Prof. Ramsay, and will be published by Messrs. Macmillan and Co., therefore treats of all the progress made in this fascinating branch of chemistry by a number of men, almost all of them English. In this sense, England may be said to "rule the air," as in another she rules the sea. The volume will contain portraits of Cavendish, Boyle, Lavoisier, and other early discoverers.

THE additions to the Zoological Society's Gardens during the past week include a Hairy Armadillo (*Dasypus villosus*) from La Plata, presented by Mr. A. H. Robinson; two Fennec Foxes (*Canis cerdo*) from Egypt, presented by Mr. Dixon Bey; a Pale Genet (*Genetta senegalensis*), two Home's Cinixys (*Cinixys homeana*), an Eroded Cinixys (*Cinixys erosa*), a Delalande's Gecko (*Tarentola delalandii*) from West Africa, presented by Mr. W. H. Boyle; a Lesser Kestrel (*Tinnunculus cenchris*) captured at sea, presented by Mr. A. J. Leith; a Greater Black-backed Gull (*Larus Marinus*), British, presented by Mr. G. Smith; one Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Mr. John J. Sapp; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mrs. Hillier; a Hawfinch (*Coccothraustes vulgaris*), British, presented by Mr. C. Bates; two Black Swans (*Cygnus atratus*, ♂ ♀) from Australia, purchased; a Gorilla (*Anthropopithecus gorilla*, ♀) from Naove or Iquela Congo Français, four Short-Death Adders (*Hoplocephalus curtus*) from Australia, deposited; an Eland (*Oreas canna*, ♂) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

PERRINE'S COMET (1895).—Some interesting photographs of Perrine's comet were taken at Prague by J. and J. Fric, during its appearance in November last (*Acad. Sci. de l'Emp. Fr. Jos.*, 1896). One of the photographs was taken on November 23 with an exposure of thirty minutes, and another a week later with an exposure of twenty minutes. The nucleus resembles an ordinary star in both cases. The tail proceeds from the head in the form of a fan opened out to about 30°, and is clearly divided into two parts. In the first photograph the northern part of this double tail is curved, and has a length of about 30′, while the other is straight, and can be traced through about $3\frac{1}{2}°$, the width being about 5′. Notwithstanding the shorter exposure of the second photograph, both tails are extended, the curved one being 50′ in length, and the other very nearly 7°. The principal tail is only 3′ wide for the first degree of its length, but it suddenly widens out and forms a band 10′ broad. We seem to have here the long straight "hydrogen" tail and the strongly-bent "iron" tail which Bredichin's theory attempts to explain.

Photographs taken at the Lick Observatory also exhibit the double tail, and Prof. Campbell's observations show that the spectrum of the comet was one consisting of carbon bands. The comet is still visible, and rises some hours before the sun. Dr.

E. Lamp gives the following ephemeris for Berlin midnight (*Ast. Nach.*, 3338).

	R.A. h. m. s.	Decl. ° ′	Brightness.
March 12	19 45 30	+5 12·8	0·09
14	45 0	5 46·4	
16	44 25	6 20·2	0·09
18	43 44	6 53·9	
20	42 56	7 27·7	0·08
22	42 3	8 1·7	
24	41 3	8 35·7	0·08
26	39 57	9 9·8	
28	38 45	9 44·0	0·07
30	19 37 26	+10 18·2	

COMET PERRINE-LAMP.—The revised elements of this comet, which have been arrived at by Dr. Lamp, indicate the following places for Berlin midnight (*Ast. Nach.*, 3338):—

	R.A. h. m. s.	Decl. ° ′	Brightness.
March 12	3 1 59	+48 34·4	0·15
14	15 11	47 41·2	0·12
16	26 9	46 51·8	0·10
18	35 25	46 6·5	0·08
20	43 21	45 25·4	0·07
22	50 17	44 47·9	0·06
24	56 25	44 13·9	0·05
26	4 1 53	43 43·1	0·04
28	6 51	43 15·1	0·03
30	4 11 22	42 49·4	0·03

The unit of brightness is that of February 15·7. On March 14 the comet will be nearly 2° south of α Persei.

ORBIT OF δ CEPHEI.—From an investigation of the displacement of the lines in the spectrum of δ Cephei, Dr. Belopolsky came to the conclusion in 1894 that the light changes of this short period variable are closely associated with an orbital movement (NATURE, vol. li. p. 282). The results have been generally confirmed by another series of photographs which were taken last year, but there are some differences in the numerical data (*Ast. Nach.*, 3338). For the velocity of the system towards the sun the later value is 15·2 English miles per second, and the time of periastron passage is altered from 1·05 days after minimum to 0·9 days. The following data for the construction of a curve of velocities of the bright star relatively to the dark one, with which we must suppose it to be associated, are derived from the figures given by Dr. Belopolsky:

Interval from minimum in days.	Relative velocity in Eng. miles per sec.
0·8	+13·4
0·5	+ 7·8
1·0	− 1·8
1·5	−10·6
1·7	−11·5
2·0	−12·9
2·5	−10·6
3·0	− 6·5
4·0	+ 1·4
5·0	+ 8·3

A + sign indicates a movement in a direction away from the sun, and a − towards the sun. The period of revolution is equal to that of the light changes, 5d. 9h., and the maximum occurs 1d. 15h. after the minimum. At the time of minimum the stars lie very nearly along a line at right angles to the line of sight, so that the reduction of light cannot be produced by an eclipse.

Attention is drawn to several notable differences in the intensities of the lines in the star spectrum and in the spectrum of the sun. Mr. Lockyer has also recognised such differences, and has shown that the spectrum of δ Cephei is practically identical with that of γ Cygni, a star of increasing temperature; four other variables of the δ Cephei class have also been shown to give a similar spectrum.

THE ABSOLUTE VELOCITY OF 61 CYGNI.—The combined results obtained for the proper motion of a star by meridian observations, and for the velocity in the line of sight by the spectroscopic method, enable the absolute velocity and direction of movement to be determined. Dr. Belopolsky has recently applied this to the brighter component of 61 Cygni, employing the velocity derived from spectrum photographs taken at Pulkowa. The mean velocity in the line of sight, corrected for the earth's movement, and thus referred to the sun, is 33·7 English miles per second towards the solar system. Taking the position of the apex of the sun's way as R.A. 267°, decl. +31°, and supposing the velocity of the solar system in space to be 9·3 English miles per second, the correction to be applied to 61 Cygni for the movement of the sun is 6·9 miles per second. Thus, the velocity of the star towards a fixed point in the direction of the sun is 26·8 miles per second.

Adopting a parallax and proper motion of 0″·5 and 5″·2 respectively, the linear velocity across the line of sight will be 30 miles per second, or, when freed from the velocity of the solar system, 22·6 miles. The resultant absolute velocity is accordingly 35 miles per second, the direction of movement having a position angle of 61° and being inclined at an angle of 140° to the line of sight.

ON THE APPEARANCE OF THE SPECTRAL LINES OF CLEVITE GAS IN STELLAR SPECTRA.

IT is very rarely that so rapid progress is made as that which followed Prof. Ramsay's discovery of the line in the yellow, corresponding with the solar line D_3, in the spectrum of the gas obtained from the mineral clevite. As early as May 9, Mr. Lockyer communicated a paper to the Royal Society,[1] in which a table was given showing that many of the unknown lines in the stars with few lines in their spectra were really due to the new gases. It seems to take some considerable time for English work of this kind to get to Berlin, for on October 24 Prof. Vogel made the same announcement to the Berlin Academy.[2] His confirmation, therefore, is of great interest.

It is not a little curious that the first star which he discusses is not one of the stars in Orion to which Mr. Lockyer had specially referred, but to β Lyræ, which the same observer had demonstrated a year or two ago to be a double star, the spectra of the components resembling that of Rigel and Bellatrix, both in Orion.

Vogel found that a comparison of the lines of this star with those in the spectrum of clevite gas showed in an unexpected manner a great number of coincidences.

His attention having been directed, in this perfectly independent manner, to the question, he was led to examine the spectra of many other stars, and to this end he employed the rich material collected by Dr. Wilsing. In the communication to the Academy, Prof. Vogel gives only a general survey of the work, leaving a more detailed account for a later publication. The first series of stars investigated were those in the constellation of Orion, for there the line λ 447 μμ plays an important part. The comparison, the results of which are here given in tabular form, exhibited many coincidences; the lines of clevite gas most common to the stars β, γ, δ, ε, ζ, λ, ν, π_3, π_5, ω of Orion were those of wave-length 382·0*, 388·9*, 402·6*, 414·4, 438·8, and 447·2*, those of helium being marked with an asterisk.

It was at first thought that, in consequence of the paucity of stars of the Orion type in other parts of the heavens, few would be found exhibiting the lines of clevite gas. An examination, however, of 150 of the brighter stars of Class I. disclosed the fact that no less than twenty-five, in which the characteristic Orion lines, or, in other words, the lines of clevite gas, were visible, were observed.

Prof. Vogel informs us that until the spectra of all the stars of Class I., down to about the 5th magnitude, have been obtained and examined, an accurate idea of the distribution of these stars in the sky cannot be formed. He further adds that a third part of this work is already accomplished. Some of the stars in which the lines in the clevite gas spectrum are well pronounced are: 102 Herculis, ι Herculis, α Virginis, γ Pegasi, β Piscium, β Cephei, *u* Herculis, ι Andromedæ, τ Herculis, ζ Draconis, η Leonis, ρ Pegasi, β Persei, η Aurigæ.

The above-mentioned investigation leads Prof. Vogel to form the following deductions with regard to stellar classification. These we give in full, remarking that while Dr. Vogel had previously classed the stars which now turn out to contain the helium lines with stars like Sirius, Mr. Lockyer had classed them apart.

[1] *P.R.S.*, vol. lviii. p. 117.

[2] *Sitzungsberichte der Königlich-Preussischen Akademie der Wissenschaften zu Berlin*, October 24, 1895.

"By an inspection of the numerous spectra my opinion is strengthened that in arranging stars according to their spectra only general marked characteristics should be considered, and a rational classification can only be thought of if based on the supposition that the various stellar spectra indicate different phases of development.

"I think it is much to be regretted that, in the extensive spectroscopic examination of all stars down to about the seventh magnitude, which Pickering by means of an objective prism has undertaken, the classification of stars, based on no general grounds, but only according to the appearance of the spectrum, which is very often misrepresented by incorrect exposure, especially in the case of brighter stars, leads him to adopt sixteen classes, denoted by the letters A–Q."

On this it may be remarked that Mr Lockyer has already shown in NATURE that Prof. Pickering's classification is quite philosophical, and that, moreover, it brings stars together to which he also has assigned special places in his classification on account of their special features.

Prof. Vogel then continues:—

"The attempt, on the lines mentioned above, which I made twenty years ago, with regard to the classification of stellar spectra has for the most part been corroborated, in spite of the great progress of stellar spectroscopy during the last few years, namely by the fine detailed researches of their spectra by Scheiner.

"In relation to the stars of Class III., direct observation of the less refrangible part of the spectrum of the photograph is yet to be considered. Of my two suggested divisions, *a* and *b*, the criterium as to which belongs to the more advanced stage of development is entirely absent. One can only say this, that in both divisions the almospheres of the stars have so far cooled as to stop the dissociation of the materials and allow compounds to be formed. There is therefore, no reason given why stars of Class III.*b*, in which chiefly the absorption bands are produced by carbon compounds, should be placed in a special Class IV. For the same reason direct observation is a good means of recognising spectra of Class II. Also here there is no reason to adopt subdivisions other than the two already assumed by me before we are in possession of more accurate investigations of the spectra of Class II.*b*.

"It is different in the case of the spectra of Class I. In these spectra the application of photography makes it in general possible to step further and obtain more minute points of difference than was the case before. It appears also that the study of the spectrum of these stars is of special interest, inasmuch as, starting from the simplest spectrum, in which only hydrogen lines are visible, the first traces of a further development can be found by the appearance of lines of other substances, and we can follow them up to the numberless lines exhibited in the spectra of Class II. Perhaps it will be possible by a more extended investigation of the details of the spectrum of Class I. to find the first beginnings and individual parts of both from successive series, the extremities of which, so different in appearance, are spectra of the type of Class III.*a* and III.*b*.

"The observations mentioned above have led me to the opinion that the appearance of the lines of clevite gas in stellar spectra, if closely watched, may give us a good basis for the classification of these spectra.

"The spectrum appearance of clevite gas has such a similarity with that of hydrogen, as has long been known to be the case, through the constant appearance of the D_3 line with the hydrogen lines at all parts of the chromosphere of the sun, as well as in the prominences, that one may expect to find, after the appearance of the hydrogen lines in the first place, that of the lines of clevite. The paucity in lines of the spectrum of this gas makes it especially easy to be at once recognised. Although the brightest line, λ 388·9 $\mu\mu$, as already mentioned, falls so near constantly the present hydrogen line $H\zeta$ in the spectrum of Class I. that a separation is impossible, and although in only very few cases does the sum-total of both these strong lines appear distinct—as, for instance, in the spectrum of β Lyræ—the lines λ 382·00 $\mu\mu$, λ 386·8 $\mu\mu$, λ 402·6 $\mu\mu$, and λ 447·2 $\mu\mu$, on the other hand, and those in the less refrangible part of the spectrum, namely λ 492·2 $\mu\mu$, λ 501·6 $\mu\mu$, and D_3, λ 587·6 $\mu\mu$, are so easy to find and recognise that the proof of the presence of clevite gas is not beset with difficulties.

"As a second point of difference for subdivisions of Class I. the presence of the calcium lines λ 393·38 $\mu\mu$ and λ 396·86 $\mu\mu$ is convenient, the second of these lines coinciding nearly with the hydrogen line $H\epsilon$ (λ 397·02 $\mu\mu$). If the first of these lines be thin and sharp, the second only influences the hydrogen line $H\epsilon$ to a very small extent. If the lines of calcium increase both in intensity and breadth, then $H\epsilon$ broadens in a very distinct manner; both lines then very soon excel with respect to intensity and thickness, the strongest and broadest hydrogen lines in the spectra of Class I. On further development they form together the characteristic pair of lines in Class II. which Fraunhofer called H."

Prof. Vogel then concludes his paper with a re-division of stars of the first class into three parts, *a*, *b*, and *c*.

Although *c* includes stars having spectra which exhibit bright lines, he suggests that from the present point of view it would be perhaps better to place them first, as they represent the first stage of development. The fact that they are here retained in subdivision *c* is because a definite conclusion has not yet been arrived at as to their true position, so the old position has, *pro tempore*, been maintained.

THE RÖNTGEN RAYS.

THE following is a summary of some of the work with Röntgen rays brought under our notice during the past week:—

The results of a scientific study of the properties of Röntgen rays are stated in a paper by Prof. G. Vicentini and Dr. G. Pacher. in a paper read before the Reale Istituto Veneto di scienze, lettere, ed arti, on January 26, and now issued as an excerpt from the *Memorie* of the Institute (vol. xxv. No. 7). The authors found distinct evidence of an irregular reflection from a parabolic brass mirror; the Crookes' tube and the sensitive plate were placed on opposite sides of an iron plate, so that the rays to reach the plate had to be reflected from the mirror. No effect was observed with a similar glass mirror, or with the arrangements used by previous observers to test the existence of reflection. Photographs accompany the paper, showing shadows of fish, a hand, two feet, and a rat with mercury introduced into its intestines. Experiments showed that a gold-leaf electroscope, turned towards the kathode, became charged positively; a wire cage, however, completely annulled the action. The following list of transparencies to Röntgen rays is interesting:—Solid bodies (opaque): Potassium, phosphorous, fused sulphur, glass, sealing-wax, tin, zinc, iron, brass, copper, lead, platinum, mercury, crystallised sulphur, rock-salt, quartz, calc-spar, fluor-spar, topaz, beryl, aragonite, baryta, lead carbonate, tourmaline, borax. Semi-transparent: Aluminium, sodium, ebonite, retort-carbon, mica (along both axes). Transparent: Cardboard, wax, paraffin, sugar, wood-charcoal, amber, shellac. Liquid bodies (opaque): Carbon disulphide, sulphuric acid (saturated solutions of), sulphates of zinc, copper, iron, cobalt, nickel and magnesium, bichloride of mercury, chlorides of sodium, ammonium and platinum, neutral oxalate of potash, potassium bichromate, and ammonium nitrate. Semi-transparent: Acetic acid, nitric acid, glycerine, ammonia, and, in a less degree, distilled water and alcohol. Transparent: Ether, benzene, in a less degree vaseline, petroleum, aniline, and olive oil. There appeared to be no clear relation between the opacity and density of the substances experimented upon.

In order to get distinct shadows of objects opaque to Röntgen rays, it is obviously necessary to avoid a penumbra, by employing a source of the rays approaching as nearly as possible to a point. The Crookes' tubes, however, as usually put on the market, are given a pear-shape, for the purpose of having as extended an area as possible under the action of the kathode rays. To obtain clear shadows with such a tube the objects must be very close to the sensitive plate or the fluorescent screen, a condition which cannot always be realised if the objects are enclosed in envelopes of considerable thickness. Prof. E. Salvioni described to the Accademia Medico-Chirurgio di Perugia, on February 22, two methods whereby the kathode rays may be brought to a point on the walls of the tube, producing a very restricted but intensely fluorescent area. In Crookes' tubes, with the usual spherical cup-shaped kathode, the rays issue from this normally, and meet in a point generally inside the tube. By moving a magnet in the neighbourhood of the tube, this focus may be brought on to the tube wall. A more convenient method of arriving at the same result was found by chance. On moving the hand over the tube, the position of the focus of the kathode rays is altered, and the same action takes place on touching the tube

with a metallic point connected to the ground or to the kathode. The rays then are attracted to a point on the tube exactly opposite to that touched by the conductor; the best position for the latter is at a distance from the kathode equal to its radius of curvature. Tubes could, of course, be constructed so that the focus of the kathode rays fell normally on the wall of the tube; it is found, however, that after some time the glass loses its fluorescent property, showing a dark spot at the incident point of the rays. The device with the metallic point enables the fluorescent spot to be changed from time to time.

The surgical aspects of photography with Röntgen rays are considered by Mr. Albert Carless in the March number of the *Practitioner*. The conclusion arrived at with reference to radiography is "that it can be of real value in a certain limited number of cases there can be no doubt, but unless very considerable improvements are made in the technique, it will be but little resorted to in practical work."

Prof. M. J. Pupin contributes to the March number of the *Engineering Magazine* (New York) an account of his experiments with Röntgen rays. He has obtained excellent results with a pear-shaped Crookes' tube, of five inches diameter, excited by a six-plate Holtz machine. He finds that a cylindrical vacuum tube without internal electrodes, but with external tinfoil coatings at the extremity of the tube, will do very well as a substitute for a Crookes' tube.

Our American correspondent writes, under date February 28: "The new art of 'radiography' is still prosecuted in America with unabated ardour. The most successful apparatus yet devised seems to be that of Prof. John S. McKay, of the Packer Institute, Brooklyn. It is a small tube five inches long, and an inch, or rather more, in diameter, which is known and sold by instrument-makers as a 'perfect vacuum' tube. This is attached directly to the terminals of the secondary coil. The copper electrodes are less than an eighth of an inch apart; but the vacuum is so perfect, that the spark will leap the whole length of the tube outside rather than cross this small interval inside. The tube produces very little light, and is sometimes, when in use, perfectly dark. This tube is light and convenient, and does not become hot like the Crookes' tube. After running it continuously for half an hour with a pressure of 200,000 volts, it is scarcely warm to the touch. But the special advantage is that the rays radiate in all directions from the centre, so that exposures may be made simultaneously within a radius of two feet from the centre of the tube. The best results were found at a distance of one foot, and with an exposure of five minutes. Experiments to determine the relative opacity of different substances show that the opacity to X-rays is generally in inverse proportion to the diathermancy of the substances tested. Thus rock-salt is most opaque; next comes alum, then glass, then quartz. Camphor gum, gum copal, and vulcanite are almost equally transparent; amber somewhat less so, and sealing-wax quite opaque. Iceland spar, mica, and selenite are quite transparent. Iceland spar seemed to give evidence of double refraction. Charcoal is quite transparent, more so than wood. Anthracite coal is somewhat opaque, but not so much as glass. Egg-shells, like bones, are opaque. Of liquids tested, mercury, sulphuric acid, glycerine, and kerosene were somewhat opaque, the opacity varying about as the density. Prof. McKay has also produced pictures on a sensitive gelatine film wrapped in paper with some metallic object upon it, and placed in the dielectric of an electric condenser, the terminals of which are connected with an induction coil or Holtz machine. After rapidly charging and discharging this condenser or Leyden jar for two or three minutes, a distinct image of the metallic body is found to be radiographed upon the sensitive film.

"A remarkable application of Prof. McKay's apparatus has been made by Edward P. Thompson, an electrician, who has devised a fluorescent screen on which shadows may be thrown showing the action of the bones in motion, as of the hand, and he hopes to show the motion of the bony skeleton of a bird in flight. It has been stated that the great drawback to aerial locomotion is our ignorance of the exact way in which a bird flies. Hence the inventor attaches much importance to his apparatus, which he calls the 'kinetoscotoscope.' It will show, among other things, the motion of the parts of a broken bone, indicating the locality and nature of the fracture, as the bones may be moved or bent back and forth before the screen, thus opening and closing the crack. The taking of pictures is not the design of this apparatus. The fluorescent screen is prepared by pulverising barium platino-cyanide to a fine powder, and pouring upon a draughtsman's tracing cloth a small quantity of varnish, or of a mixture of oil and turpentine, stirring the powder in with it, and drying."

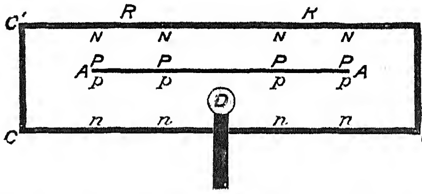
With regard to seeing Röntgen shadows by means of a fluorescent screen, Mr. Swinton informs us that he finds that instead of employing blotting-paper saturated with barium platino-cyanide, it is much better to make a hot emulsion of the barium platino-cyanide in gelatine and water, and apply this in a thick coat to a piece of glass On cooling, the barium platino-cyanide crystallises out, and the gelatine protects it from abrasion. A thick and uniform coating is what is wanted. The glass being rather opaque to the X-rays, but transparent to light, the plate should be obviously placed with the gelatine side next to the Crookes' tube, and the glass side next the eye.

ON THE GENERATION OF LONGITUDINAL WAVES IN ETHER.[1]

In a short note published in NATURE of February 6, I suggested an arrangement of four insulated and electrified spherical conductors with their centres in one line, giving rise to ethereal waves in the surrounding atmosphere, of which the disturbance in the line of centres is essentially longitudinal. But at any finite distance from this line there must also be laminar or distortional waves of the kind expressed in Maxwell's equations. The object of my present communication is to show an arrangement by which a large space of air is traversed by pressural disturbance, or by waves essentially longitudinal, or by condensational-rarefactional vibrations; with but a very small proportion, practically evanescent, of laminar waves.

Let AA be a plane circular metal plate insulated within a metal case CCC′C′, as indicated in the drawing. Let D be a discharger which can be pushed in so as to make contact with A.

Let A be charged to begin with, positively for instance as indicated by the letters PP*pp*; NN*nn* showing negative electricity



induced by it. Let now the discharger be pushed in till a spark passes. The result, as regards the space between AA and the roof RR over it, will be either an instantaneous transmission of commencement of diminution of electrostatic force, or a set of electric waves of almost purely longitudinal displacement, according as ether is incompressible or compressible.

Hence, if the theory of longitudinal waves, suggested by Röntgen as the explanation of his discovery (for the consideration of which he has given strong reasons), be true, it would seem probable that a sensitive photographic plate in the space between AA and RR should be acted on, as sensitive plates are, by Röntgen rays. Either a Wimshurst electrical machine or an induction-coil, adapted to keep incessantly charging AA with great rapidity so as to cause an exceedingly rapid succession of sparks between D and A, might give a practical result. In trying for it, the light of the sparks at D must be carefully screened to prevent general illumination of the interior of the case and ordinary photographic action on the sensitive plate.

The arrangement may be varied by making the roof of sheet aluminium, perhaps about a millimetre thick, and placing the sensitive photographic plate, or phosphorescent substance, on the outside of this roof, or in any convenient position above it. When a photographic plate is used there must, of course, be an outer cover of metal or of wood, to shut out all ordinary light from above. This arrangement will allow the spark gap at D to be made wider and wider, until in preference the sparks pass between AA and the aluminium roof above it. The transparency of the aluminium for Röntgen light will allow the photographic plate to be marked, if enough of this kind of light is produced in the space between the roof and AA, whether with or without sparks.

[1] A paper by Lord Kelvin, read before the Royal Society on February 13

The new photography has hitherto, so far as generally known, been performed only by light obtained from electric action in vacuum; but that vacuum is not essential for the generation of the Röntgen light might seem to be demonstrated by an experiment by Lord Blythswood, which he described at a meeting of the Glasgow Philosophical Society on Wednesday, February 5. As a result he exhibited a glass photographic dry plate with splendidly clear marking which had been produced on it when placed inside its dark slide, wrapped round many times in black velvet cloth, and held in front of the space between the main electrodes of his powerful Wimshurst electrical machine, but not in the direct line of the discharge. He also exhibited photographic results obtained from the same arrangement with only the difference that the dark slide, wrapped in black velvet, was held in the direct line of the discharge. In this case the photographic result was due, perhaps wholly, and certainly in part, to electric sparks or brushes inside the enclosing box, which was, as usual, made of mahogany with metal hinges and interior metal mountings. It is not improbable that the results of the first experiment described by Lord Blythswood may also be wholly due to sparking within the wooden case. I have suggested to him to repeat his experiments with a thoroughly well closed aluminium box, instead of the ordinary photographic dark slide which he used, and without any black cloth wrapped round outside. The complete metallic enclosure will be a perfect guarantee against any sparks or brushes inside.

If the arrangement which I now suggest, with no sparks or brushes between AA and the roof, gives a satisfactory photographic result, or if it shows a visible glow on phosphorescent material placed anywhere in the space between AA and the roof above it, or above the aluminium roof, it would prove the truth of Röntgen's hypothesis. But failure to obtain any such results would not disprove this hypothesis. The electric action, even with the place of the spark so close to the field of the action sought for as it is at D, in the suggested arrangement, may not be sudden enough or violent enough to produce enough of longitudinal waves, or of condensational-rarefactional vibrations, to act sensibly on a photographic plate, or to produce a physical glow on a phosphorescent substance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At a Congregation held on Tuesday, the series of resolutions relating to the claims of women, the consideration of which was adjourned last week after the rejection of the proposal for admitting women to the B.A. degree, were discussed and rejected.

CAMBRIDGE.—Mr. Charles Davison, well-known for his researches on earthquakes and and other seismic phenomena, has been approved by the General Board of Studies for the degree of Doctor of Science.

The Isaac Newton Studentship in Astronomy and Physical Optics has been conferred on Mr. John Gaston Leathem, Scholar of St. John's College.

Dr. Joseph Griffiths has been appointed an additional Examiner in Surgery.

The Panjab University has, like the University of Calcutta and Allahabad, become affiliated to the University of Cambridge. Graduates in Arts of the Panjab are thereby exempted from the previous examinations, and may proceed to their degree by means of a Tripos Examination after two years' residence in Cambridge.

The Syndicate for the consideration of the question of degrees for women has been nominated, and consists of the Vice-Chancellor, Dr. Butler, Master of Trinity, Dr. Peile, Master of Christ's, Mr. Austen Leigh, Provost of King's, Prof. E. C Clark, Prof. Clifford Allbutt, F.R.S., Prof. Sidgwick, Dr. Jackson, Prof. Forsyth, F.R.S., Dr. Keynes, Prof. Armitage Robinson, Prof. Foster, F.R.S., Mr. R. T. Wright, Mr. W. L. Mollison, and Mr. R. A. Neil. Its appointment will be opposed on the ground that an excessive proportion of its members have already committed themselves to definite views on the questions at issue, and that only two members of less than twenty years' standing are included.

The Examination in Sanitary Science for the diploma in Public Health will begin on April 7, and will extend over ten days.

A conversazione will be held to-night in the Cavendish Laboratory, in commemoration of the opening of the new buildings. The President of the Cambridge Philosophical Society (Prof. J. J. Thomson) and Mrs. Thomson are the hosts.

THE hall which Mr. M'Ewan has added to the Edinburgh University buildings, at a cost of between £60,000 and £70,000, will be opened early in the ensuing summer.

THE University of Indianapolis has just been organised by representatives of Butler College, the Medical College of Indiana, the Indiana Dental College, and the Indiana Law School.

PRESIDENT JOHN M. COULTER, of Lake Forest University, has resigned in order to accept the head Professorship of Botany in the University of Chicago, which has been endowed with 1,000,000 dollars in its Botanical Department.

THE following are among recent appointments:—Dr. Christopher Childs to be Assistant in the Hygienic Department at University College, London, under the direction of Prof. Corfield; Dr. Allan MacFadyen to act as hon. secretary of the British Institute of Preventive Medicine; M. Salih Zéky to be Director of the Observatoire Impérial Météorologique et Séismique at Constantinople, in succession to the late M. A. Coumbary; Dr. W. Kurchinski, of Kieff, to be appointed Extraordinary Professor of Physiology at Turieff (Dorpat).

THE Executive Committee of the City and Guilds of London Institute have awarded the second Salters' Company's Research Fellowship, for the encouragement of higher research in chemistry in its relation to manufactures, to Dr. Sidney Williamson, who was for two years a student at the City and Guilds Technical College, Finsbury, and subsequently for three years at the City and Guilds Central Technical College. The Fellowship is tenable at the latter, and Dr. Williamson proposes to work on some questions bearing on food-stuffs generally, more particularly the examination of some definite albumenoids, with the ultimate object of ascertaining the influence of various manures on the growth of crops in so far as *quality* of produce is concerned.

THE Middlesex County Council have voted the sum of £10,785 for the purpose of technical education classes in the county during the current year. This is a slight increase on the amount appropriated during 1895, but since the available amount exceeds twenty-two thousand pounds, there still remains a large surplus which ought to be devoted to its proper purpose. The explanation of the unwillingness of the Council to benefit education in their midst to the fullest possible extent may be found, perhaps, in the falling off in the number of candidates for county scholarships. This diminution is most marked. For the fifteen scholarships of £20 each for three years for boys, there were 100 candidates fewer than in 1893, in which year the scholarships were first offered. The decrease in the number of competitors has been gradual. In 1894 the number was 220, in 1895 it had fallen to 184, and it is less again this year. As there are at least 80,000 children in elementary schools in Middlesex, the number of candidates ought certainly to be much larger.

The Report of the Director of Technical Instruction to the County Council for the County Palatine of Lancaster for the year ending August 31, 1895, which was presented to the Council at a meeting held on the 6th ultimo, contains many interesting statistics of the work which is being accomplished in Lancashire. The work in many departments is pre-eminently satisfactory. We are glad to notice that the Committee have made a grant of £250 to each of the University Colleges of Liverpool and Manchester, for we believe that one of the surest ways of improving the education of any county is to strengthen the centres of higher instruction within its borders. It is certainly one of the weaknesses of the Lancashire scheme for technical education that they give no assistance to secondary schools in their county. The middle classes are as much in need of all kinds of education as any section of the community, and though in Lancashire the following annual grants can be afforded—viz. horology, £500; plumbing and sanitary science, £750; horticulture and bee-keeping, £500; practical agriculture (including veterinary science, poultry-keeping, and allied subjects), £1000; as well as grants to encourage the study of music, yet for the development of the modern side of their secondary schools nothing is allowed. It is interesting to compare the decision of the Lancashire Committee with the recommendation of the recent Commission, "that this grant . . . ought to be all of it paid in future to the local authorities for secondary education . . . not merely to technical education,

but to secondary education generally." The work completed during the past year on the County Council Farm at Hutton has been very successful, both as regards the instruction given and the amount of research work carried out. It seems rather anomalous that while Preston devotes no part of its share of the Customs and Excise Fund to the purposes of education, yet, as the report shows, the County Committee make a grant of £650 a year to the Harris Institute in that town. Surely the borough authority will not abstain much longer from following so good an example.

We learn from the February number of the *London Technical Education Gazette*, that seventeen secondary schools in different parts of the metropolis have been aided by grants from the Technical Education Board of the London County Council. These grants have been very useful in encouraging the establishment of laboratories and science lecture-rooms in schools which have hitherto been without these advantages, and in improving the equipment and teaching in schools in which practical science has been taught. We notice with much satisfaction that in a large number of these schools physical laboratories have been provided, and that every facility is being given for the study of practical physics as well as chemistry. Too much stress cannot be laid upon the incompleteness of that practical science teaching which confines the student's attention to elementary qualitative analysis, and we note that it has been already found that "the influence of the Board's grants is as much apparent in the character of the teaching given in the several schools as in the appliances available for such teaching." The old method of teaching practical chemistry is giving place "to a more rational system, in which the laboratory and the lecture-room are brought into close relation, and in which the importance of measurement is insisted upon as the basis of all scientific work." Two at least of the schools receiving aid are for girls. A laboratory and lecture-room in James Allen's Girls' School, Dulwich, and a laboratory for practical science and school of domestic economy at the Camden School for Girls, have been equipped at the cost of the Board. The London Committee are, in this matter, as in so many others, setting the country local authorities an example which we hope soon to see emulated. The development following upon these grants can be seen at a glance from the statistics collected by the Board's science inspector, and published in these columns on February 13 (p. 357).

The cost of the new technical school at Salford, which is to be shortly opened by the Duke and Duchess of York, is likely to amount to £70,000. This amount is in excess of the anticipated cost, and the original loan of £55,000, sanctioned by the Local Government Board, is to be augmented by a further one of £13,500. Even then the difficulty of the expenses of maintenance will have to be faced. The experiences of the Salford Committee show only too plainly the necessity for legislation to prevent the appropriation of accumulated funds from the technical education grants of former years for ordinary purposes in the district. The Technical Instruction Committee of Salford had up to March 1894, been holding in reserve moneys received under the Local Taxation (Customs and Excise) Act of 1890, but the corporation becoming involved in financial difficulties, laid hands on these moneys, which amounted to £12,000. It is now left to the Committee to meet a heavy annual expenditure out of their revenue from the rate of a penny in the pound, the fees, grants, and other sources of income.

As a supplement to last week's account of what has been done for the support of education by some of the London Livery Companies, it is interesting to note the efforts in the direction of (probably) the only surviving provincial Company of the same type—the Master, Wardens, and Commonalty of Merchant Venturers of the City of Bristol. The supreme importance, for a commercial and manufacturing people, of what is now known as "technical instruction" seems to have been realised in Bristol earlier than in most other parts of England; for as long ago as 1856 there was founded in that city the Bristol Diocesan Trade School (afterwards called the Bristol Trade and Mining School), for the express purpose of providing sound and systematic education for the industrial classes. The school, being appreciated by those for whom it was intended, soon acquired a more than local reputation, and steadily grew in numbers, up to the limit which its buildings and its finances imposed. In 1880, when this limit had been reached, it happened that the Merchant Venturers—whose work of creating, and governing for centuries, the port of Bristol was then accomplished—resolved to devote their energies for the future to the furtherance of education; and, seeing the position of the Trade and Mining School, and the great value of the kind of teaching which it supplied, agreed to adopt it. Accordingly, at an outlay of some £45,000, they provided it with new buildings, upon a larger site, and with a more complete equipment; they also undertook to maintain it and develop it upon existing lines; and they gave it their own name. The Merchant Venturers' Technical College, as it is now called, has a junior department, a senior department, and a multitude of evening continuation classes; so that any boy, or young woman, destined for an industrial occupation of whatever kind—whether as architect, engineer, designer, chemist, dressmaker, or the like—may both begin and finish his or her entire education within its walls. The total number of students now exceeds 2000. In keeping with the special object of the institution, its curriculum is limited to comparatively few of the main branches of knowledge, and necessarily leaves out many of the most important. It hardly touches, for instance, the fascinating realm of literature, ancient and modern, or the subjects of music, medicine and law; and it ignores altogether the whole range of the mental and moral sciences. But ample provision for the teaching of all these exists, or can be made, in the other schools and colleges which Bristol is so fortunate as to possess, and thus the Merchant Venturers are enabled to occupy, with undivided attention, their own restricted field of operations, and to carry out, with ever-increasing thoroughness, their scheme of industrial or technical education sketched out forty years ago. Not a term passes without some addition to the apparatus with which their College is equipped, and hardly a session without provision for some newly-recruited trade or class; and it is an open secret that, as soon as the necessary land can be acquired, the extent of the buildings, and the convenience and efficiency of every department, will be very largely increased. It may well be supposed that no effort will be spared to enable the College to keep the lead, which it has hitherto held, in matters pertaining to technical instruction, or to ensure that, in this respect, it shall remain without a successful rival in the West of England. The Merchant Venturers, like their brethren in London, have a position to justify, a character to maintain, a distinguished past which they must not disgrace; and it is likely that, in the new work to which they have set their hands, they will evince the same activity and perseverance, and the same prudent liberality in furnishing means for the attainment of their ends, as characterised them in olden times, when their ventures were mostly for their own private gain, rather than, as now, for that of the community.

SCIENTIFIC SERIALS.

American Journal of Science, February.—Researches in acoustics, by A. M. Mayer. This paper, dealing with the variation of the modulus of elasticity with change of temperature, and the acoustic properties of aluminium, was read before the British Association at the Oxford meeting.—On the improbability of finding isolated shoals in the open sea by sailing over the geographical positions in which they are charted, by G. W. Littlehales. Suppose that A discovers, in the open ocean, a shoal r miles in radius, and determines the geographical position of its centre subject to extreme errors of m miles in longitude and n miles in latitude; and that B, who is able to establish his geographical position within the same limits of extreme error as A, attempts to find the shoal again by proceeding to the geographical position assigned to it by A, what is the probability that he will find it? The author works out this probability mathematically, and finds a general formula for it. If $r = 1$ mile, and m and $n = 10$ miles, B would stand one chance in 6173 of coming within two miles of the shoal. This shows that the reported non-existence of a charted shoal must be accepted with great care.—The counter-twisted curl aneroid, by Carl Barus. A curl aneroid, less than a metre long, provided with a mirror for registry, will indicate variations of atmospheric pressure of a thousandth of a millimetre of mercury, provided the mounting is sufficiently free from tremor, and the temperature is kept constant to a few thousandths of a degree during the interval of observation. The conditions are made much less severe if the coiled tube, after being twisted, is kept untwisted by a spiral spring. Effects of viscosity and rigidity may be thus compensated.

Wiedemann's Annalen der Physik und Chemie, No. 2.—Methods of determining dielectric constants, by W. Nernst. The author employs a bridge in which two branches are always equal; the third contains the dielectric trough, and the fourth a variable resistance and a variable capacity in parallel. Connecting two opposite terminals with a high-frequency induction coil, and the two others with a telephone, the latter is only silent when the resistance and the capacity in the fourth branch are equal to those of the dielectric in the third. An attempt to verify this by comparison with the electrometer method was foiled by the uncertainty of the latter.—A modification of the electrometer method, by J. F. Smale. This is based upon the attraction of a needle immersed in the dielectric by conductors kept at a constant potential. The conductors are two semi-ellipses nearly surrounding the flat needle of platinum, which is suspended by a quartz fibre. The deflection of the needle from its position of rest is proportional to the dielectric constant of the medium. A comparison with Nernst's method gave practically identical results.—An apparatus for varying self-induction, by Max Wien. This consists of a fixed and a movable coil. The fixed coil is subdivided into four, each of which can be placed in circuit, so that the self-induction can be abruptly changed. The interval between each abrupt change is filled up by moving the movable concentric coil about its diameter, by means of an arm travelling over a graduated circle. The range of the apparatus is very large, and self-inductions from 5×10^{3} to 10^{10} can be measured.—Refraction and reflection of electric waves by water and alcohol, by A. D. Cole. For waves 300 to 600 cm. long, water has an index of refraction of 8·95, alcohol 5·20. Calculated by Fresnel's formula from the reflection of polarised rays, the refractive indices for wave-lengths of 5 cm. come out as 8·8 for water, and 3·2 for alcohol; so that alcohol shows a remarkably higher refraction for long than for shorter waves.—Lowest temperatures and the liquefaction of gases, by C. Linde. Air is liquefied exclusively by the action of its own expansion, each portion of the expanded air being conducted past the next expanding proportion, and cooling it down to a lower temperature. The apparatus is almost identical with that recently described by Prof. Dewar, but the author claims priority.—The wave siren, by Rudolph König. This paper contains the results of a minute and careful investigation of the behaviour of the air current in a wave-siren. The air is blown through a slit, which is lengthened or shortened by the curved edge of a plate rotating in front of it. Any tone is thus directly reproduced from its wave-form. The air current remains sharply defined to a distance of about 1 cm. from the slit, and the wave-plate need therefore not be mounted very close to it. There is no accumulation of air by the closed portions of the slit leading to irregularities in the tone, and the vortex effects at the edges are without any influence upon the tone. The loudness of the sound produced by a simple sine curve increases with the width of the slit, reaching a maximum where the width is half the wave-length. Most vowels can be correctly reproduced from their known wave-forms.

Bollettino della Società Sismologica Italiana, vol. i., 1896, No. 9.—Review of the principal eruptive phenomena in Sicily and the adjoining islands during the four months, May-August, 1895, by S. Arcidiacono.—Notices of Italian earthquakes (July-August, 1895), by M. Barratta, the more important being those of the Comacchio earthquake of July 30, and part of those of the Adriatic earthquake of August 8.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 30.—"On the Rhythmic Contractility of the Spleen." By E. A. Schäfer, F.R.S., and B. Moore.

The authors have investigated the rhythmic contractility of the spleen, which was discovered by Roy (*Journ. Physiol.*, vol. iii.), and the influence of nerves, drugs, and animal extracts upon it. For this purpose the changes in its volume have been studied by aid of a specially constructed plethysmograph, so arranged as to afford the least possible obstruction to the blood-vessels entering and leaving the hilum. Under these circumstances, the spleen exhibits evidence of responding immediately by alterations in volume to every alteration in blood pressure, respiratory and cardiac, and *à fortiori* to such greater changes as are produced by compression of the aorta (contrary to Roy). This is even manifest when the organ is left connected with the rest of the vascular system by one artery and vein only. The conclusion which Roy arrived at, that the spleen is practically cut off from the arterial system, and that its circulation is maintained by its own contractions, is thus shown to be incorrect.

The rhythmic contractions are independent of the central nervous system.

They are excited to increased activity by intravenous injection of certain drugs and animal extracts which act specifically upon the organ. Indifferent fluids, such as normal salt solution, produce in moderate quantity no such effects (contrary to Roy).

Dyspnœa causes marked contraction of the spleen. This contraction is of central origin, for after severance of all nerves to the organ it is replaced by a passive dilatation, due to the rise of general blood pressure, followed by an increase in extent of the rhythmic contractions. Temporary cessation of the blood flow through the organ also has the effect of increasing their extent, probably because the splenic tissue is thereby deprived of oxygen.

The splanchnics contain not only nerve fibres which produce contraction of the spleen, but also others which cause dilatation.

There is no evidence that the vagi contain any centrifugal fibres which influence the volume of the spleen (contrary to Roy). Provided their inhibitory action upon the heart is neutralised by atropine, even the strongest stimulation of the peripheral end of either cut vagus produces no direct effect upon the spleen.

There is evidence of the existence of numerous afferent (sensory) fibres in the nerves supplying the spleen.

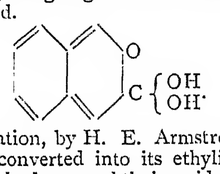
Entomological Society, February 19.—Prof. Raphael Meldola, F.R.S., President, in the chair.—Dr. D. Sharp, F.R.S., exhibited preparations of *Dytiscus latissimus* and *Cybister roeselii*, to show the so-called secondary wing, noticed by Meinert. He stated that this structure is only a part of the elytron, to which it is extensively attached, and that he considered that it corresponded with the angle at the base of the wing seen in so many insects that fold their front wing against the body. He could not consider that this structure afforded any support to the view that the elytra of beetles correspond with the tegulæ of Hymenoptera rather than with the front wings. He also exhibited specimens of Neuroptera, and pointed out that this secondary wing agreed in position and structure with a small lobe on the front wing of Raphidia. Mr. McLachlan, Prof. Meldola, and Mr. Gahan made some remarks on the subject.—Mr. C. G. Barrett exhibited, for Dr. H. G. Knaggs, cells of *Retinia resinana* formed of resin but lined with wax. A portion of the cell had been removed and the resin dissolved away with spirit, leaving a slight film of wax. Mr. Tutt stated that a secretion of wax had been detected by Dr. Chapman in *Parnassius apollo*. Prof. Meldola suggested that as Dr. Knaggs had shown how to separate the resin from the wax, it would be of interest to make a chemical investigation of the latter, since a sufficient supply of this material could easily be obtained. No insect wax, with the exception of that of the bee, had been submitted to investigation by chemists. Mr. Hampson and Mr. Blandford continued the discussion.—Mr. Gahan exhibited drawings of the dorsal segments of the abdomen of *Dyscritina longisetosa*, formerly described by Prof. Westwood in *Trans. Ent. Soc.*, 1881, a specimen of which was shown by Mr. E. E. Green at the last meeting of the Society. He regretted that no drawing, showing the ventral service, had yet been prepared.—Mr. B. A. Bower exhibited specimens of *Argyresthia atmoriella*, Bankes, taken in Kent, in June 1894, a recent addition to British Lepidoptera.—Mr. Green read notes on the habits of the Indian ant, *Œcophylla smaragdina*, Fabr. He said he believed that at some previous meeting of the Society, Mr. Ridley, of the Singapore Museum, made some remarks on this ant and its supposed habit of using its own larvæ as web-spinners in the formation of its nest, but he had not been able to find anything on the subject in the *Proceedings*. Mr. Green stated that he was now able to produce corroborative evidence from an independent source. The facts were noted by his friend Mr. W. D. Holland, of Balangoda, Ceylon, a most careful observer. Mr. Green exhibited the specimens referred to by Mr. Holland, and pointed out that the larvæ were still tightly grasped by the jaws of the ants, and he thought it probable that other web-spinning ants utilised their larvæ in the same way. Mr. Hampson said he could confirm this statement.—Mr. G. F. Scott-Elliot read a paper entitled "Notes on Flower-Haunting Diptera." The author pointed out that some of the higher types of Diptera

appeared to prefer red and blue flowers, and more often visited the complicated types of plants than the smaller Hymenoptera. He also alluded to the effect of insect visitors in isolating particular individuals. Prof. Meldola stated that although he was aware, from the writings of Hermann Müller and others, that Diptera played an important part in the fertilisation of flowers, he was unaware of the very great importance which these insects possessed for the function of pollination until he heard Mr. Scott-Elliot's paper. He also called attention to the urgent need of a manual of British Diptera. Mr. R. Trimen, F.R.S., mentioned that in South Africa some species of Orchidaceæ were fertilised by Diptera. Dr. Sharp said Prof. Plateau thought that neither the colour nor form of the flower played any part in attracting insects. Mr. McLachlan remarked that the flowers of Scrophularia possessed a great attraction for wasps. Lord Walsingham, F.R.S., inquired whether any observation had been made as to the Diptera which visited differently coloured flowers of the same species, such as Petunias. Mr. Barrett, Mr. Green, and Mr. Scott-Elliot continued the discussion.—Mr. Tutt read a paper, by Prof. A. Radcliffe-Grote, entitled "On the Nomenclature of the Geometridæ."—A discussion on the rules of nomenclature followed, in which Lord Walsingham, Prof. Meldola, Mr. Hampson, and Herr Jacoby took part.

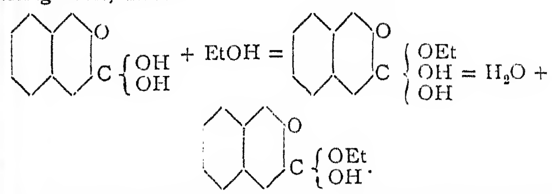
Royal Meteorological Society, February 19.—Mr. Edward Mawley, President, in the chair.—The report on the phenological observations for 1895 was presented by Mr. Mawley, in which it was shown that, owing to the great frost at the beginning of the year, all the first spring flowers made their appearance very late; and it was not until the middle of June that plants began to come into blossom in advance of their usual time. During July the dates recorded were, as a rule, exceptionally early. The yield of all the farm crops, except potatoes, was exceedingly poor. Pears and plums yielded badly, but there was a splendid crop of apples, and also of all the small fruits. As regards vegetation generally, seldom has a year ended under conditions as favourable for the one succeeding it.—Mr. R. H. Scott, F.R.S., read a paper on the recent unusually high barometer readings in the British Isles, in which he stated that the Daily Weather Chart for 6 p.m. on January 8, was the first in these islands that ever showed 31 inches. The station was Stornoway, and by the next morning all over the northern portions of Great Britain and Ireland the barometers were above 31 inches. The highest reading of all was 31·119 inches, photographically recorded at Glasgow at 9 a.m. on the 9th. The barometric pressure then gave way, and the region of highest readings moved southwards along our west coast, and finally left the south of Ireland on the 15th. Weather throughout the period was mild, an unusual thing with a very high barometer. At the end of the month a second anticyclone spread over the country, when the barometer rose to 30·96 inches at Cork. Reference was made to previous excessively high barometer readings in England and in Siberia, and it was stated that a reading of 31·62 inches at Barnaoul in Siberia, in 1877, was probably the highest ever observed.—Mr. R. Inwards read a paper on Turner's representations of lightning, which he considered to be true to nature, and demonstrated the same by placing an actual example of Turner's work side by side with a photograph of a real flash of lightning.

Linnean Society, February 20.—Mr. C. B. Clarke, F.R.S., President, in the chair.—Mr. Clement Reid exhibited a collection of acorns planted by rooks, and made remarks upon the agency of these and other birds in the dispersal of seeds. A discussion followed, in which the President and Messrs. Cole, Druery, Harting, and Kirby took part.—Mr. Bernard Arnold exhibited and made remarks upon an abnormal growth of *Dactylis glomerata*, Linn., gathered at Shorne, near Gravesend, criticisms being offered by Messrs. B. Daydon Jackson and H. Groves.—Mr. W. H. Lang exhibited under the microscope some prothalli of several varieties of *Nephrodium Filix-mas*. These illustrated the apogamous production of the sporophyte which has been described in this species by De Bary and Kny. Dr. D. H. Scott and Mr. C. T. Druery took part in the discussion which followed.—On behalf of Mr. John Young there was exhibited an unprecedented case of hybridism between *Carduelis spinus* and *Linota cannabina*, the formerbeing the male parent. Some remarks were made on the subject by Mr. Harting, who took occasion to exhibit, on behalf of Captain M. Murphy, another hybrid, viz. one between black grouse and pheasant, which had been shot near Bunessan, Mull, in the month of January last.—On behalf of Mr. E. J. Lowe, F.R.S., a paper was read by Mr. Druery in which details were given regarding the culture of divided and redivided prothalli of *Scolopendrium vulgare*. Apart from the fact that by such subdivision and the consequent separation of parts bearing archegonia and antheridia, the oophoric stage of fern life was maintained for a number of years without the sporophoric generation appearing; the ultimate results, when fertilisation eventually took place, were very remarkable. In numerous instances several marginal plants appeared on the same prothallus of presumably the parental type; but single plants originating from the centre of each prothallus were, though of varying character, all distinguished by bearing prothalli upon their edges or terminal points, such prothalli developing root-hairs, archegonia and antheridiæ, although the young plants had formed a distinct axis of growth and thrown up a circle of such aposporous fronds. The paper embodied also the observations of Mr. C. T. Druery, Prof. F. O. Bower, Prof. Farmer, Dr. Scott, and Mr. Lang on material sent to them, and one of the plants in question, clearly showing the aposporous growths, was exhibited by Mr. Druery in illustration. A discussion followed, in which Dr. Scott, Mr. Lang, and Mr. Druery remarked upon the interesting nature of these and similar breaches of the law of alternation of generations in the Archegoniatæ.

Chemical Society, February 20.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—The origin of colour, No. XI. The yellow colour of 2:3-hydroxynaphthoic acid, by H. E. Armstrong. The yellow colour possessed by this naphthoic acid and its salts may be readily explained by assigning to it an orthoquinonoid structure of the following kind.



—Note on etherification, by H. E. Armstrong. 2:3-hydroxynaphthoic acid is converted into its ethylic salt more readily than the isomeric α-hydroxynaphthoic acid; an acid having the constitution indicated above should readily combine with alcohol yielding a substance which could easily give the ethylic salt by losing water, thus:—



—The relation of pinene to citrene, by H. E. Armstrong.—The conditions involved in the occurrence of inversion in the case of asymmetric (optically active) compounds, by H. E. Armstrong. The remarkable conversion of dextro- or lævo-malic acid into its optical antipodes is possibly due to the formation of a chlorophosphonium compound, which is then acted on by hydrogen chloride giving chlorosuccinic acid and phosphorus oxychloride. The production of naphthalene and of isoquinoline derivatives from dehydracetic acid, by J. N. Collie and N. T. M. Wilsmore. The yellow condensation product obtained from diacetylacetone is a benzene derivative, and condenses with ammonia, giving two isoquinoline bases.—Note on a difficulty encountered in the determination of nitrogen by the absolute method, by W. R. Dunstan and F. H. Carr. Very high values are obtained on determining the nitrogen in aconitine by the absolute method; this is shown to be due to the formation of methane during the combustion. Experiments with mixtures of methane and nitrogen show that the hydrocarbon in the diluted state is only burnt with great difficulty by red-hot copper oxide. —Mixed diazoamides containing an orthonitro-group, by R. Meldola and F. W. Streatfeild.—Allyl-p-dinitrodiazoamidobenzene: a study of the relations between melting-point and constitution, by R. Meldola and F. W. Streatfeild.

Edinburgh.

Royal Society, February 17.—Prof. Copeland in the chair. —Prof. John G. M'Kendrick made five communications. He first described the case of a boy, four and a half years old, who showed a remarkable appreciation of pitch, being able at once to

name any note struck on a piano. Then followed a demonstration of the acoustic turbine of Dvoràk and Mayer, and of a flame so sensitive that it was affected by the ticking of a watch. Next, Prof. M'Kendrick exhibited Graham's method of producing a musical tone in a circuit containing a variable resistance apparatus and a telephone. The sound emitted was like that of a cornet or flute. Finally, Prof. M'Kendrick made some further observations on the phonograph. He described apparatus by which the sounds could be magnified, and detailed his methods of studying the curves on the wax cylinder, of which he exhibited photographs. He showed that each note and sound had its characteristic curve, and, to show it, spoke the words "Arrubnidē fo Eetisrevenū" into a machine moving backwards, and the meeting was considerably startled to hear, on the instrument being turned in the proper direction, the words coming out "University of Edinburgh."

Cambridge.

Philosophical Society, February 10.—Prof. J. J. Thomson, President, in the chair.—Exhibition of a method of measuring osmosis at atmospheric pressure, by Dr. Lazarus-Barlow.—Exhibition of specimens showing the communication between the peritoneal cavity and renal veins through the nephrostomial tubules in the frog, by E. J. Bles.—On the effect of currents on the assimilation of water-plants, by F. Darwin and D. F. M. Pertz. The amount of gas given off by water-plants under the influence of light is markedly increased by continuously stirring the water. This holds good in the case of Elodea, but only under certain circumstances with Potamogeton. That form of gas-evolution which continues in darkness, owing to the gas-pressure in the water, is also increased by disturbing the water. The authors described simple methods of showing the effect of barometric pressure and of surface tension on the yield of gas.—On a collection of plants from New Britain (*Neu Pommern*), by I. H. Burkill. This collection was brought home by Baron A. von Hügel, having been made in the neighbourhood of Blanche Bay. There are in it a number of species not hitherto known as natives of New Britain; among them a new *Eranthemum* described as *E. Huegelii*. The name *Alpinia oceanica* is suggested for a plant described by Prof. K. Schumann as *A. nutans*: this being also held as possibly not identical with Rumphius' *Globba sylvestris minor*. The total number of species known from New Britain is still small, two-thirds of them having been found in German New Guinea, and about one-half in the Fiji Isles.

Paris.

Academy of Sciences, March 2.—M. A Cornu in the chair.—On the divergence of the series used in astronomy, by M. H. Poincaré. The results obtained by M. Hill are shown to be in agreement with those previously obtained by the author, the contradiction being only apparent.—Observations on the subject of photography through opaque bodies, by M. A. d'Arsonval. In reviewing the work of M. G. Le Bon and his critics, it is shown that their results are not necessarily contradictory. The solar rays do not appear to penetrate a thin plate of metal, even of aluminium; if a plate of glass, however, especially a fluorescent glass, be placed above the metal screen, the photographic plate is affected.—On the invisible radiations emitted by phosphorescent bodies, by M. Henri Becquerel. The light emitted by crystals of uranyl-potassium sulphate, $K(UO).SO_4 + H_2O$, can pass both through thin sheets of metal and also through black paper. This effect was first shown by covering a sensitive film with a metal screen, placing some crystals of the double sulphate on this, and then exposing to sunlight. But it was afterwards found that the crystals exerted the same photographic effect in the dark, a phenomenon which can hardly be attributed to phosphorescence, since $\frac{1}{100}$th of a second after exposure to light, these radiations are no longer visible (see p. 445).—The relation between the energy of muscular work and albuminoids in food, by MM. A. Chauveau and C. Contejean. The albuminoids in food are not directly concerned with the production of muscular energy, since the amount of nitrogen excreted in the urine is independent of the work done by the animal.—Observations on the Comet Perrine (1895 *c*), made at the Observatory of Toulouse with the Brunner equatorial, by M. F. Rossard.—On a means of recognising small variations in the rate of astronomical clocks, by M. G. Bigourdan. The use of a free pendulum, working in a vacuum at a constant temperature, is suggested.—On groups of operations, by M. Levavasseur.—Reply to the observations of M. H. Poincaré on the theory of the kathode rays, by M. G. Jaumann.—Observations on the subject of the preceding communication, by M. H. Poincaré. Presentation of prints obtained by M. Röntgen's method, by M. Londe.—Dark light, a reply to some criticisms, by M. Gustave Le Bon.—Diffusion of the Röntgen rays, by MM. A. Imbert and H. Bertin Sans. The experiments show that if the rays are regularly reflected, it must be only to a very small extent; they can, however, be readily diffused, and the diffusion appears to depend rather on the nature than on the condition of the surface of the diffusing body.—On the photographic representation of a medal obtained by the Röntgen rays, by M. J. Carpentier.—On the passage of the Röntgen rays through liquids, by MM. Bleunard and Labesse. Water, either coloured or not, and solutions of borax and potassium permanganate are transparent to the rays. Solutions of potassium bromide, antimony chloride, and potassium bichromate, on the other hand, are not so transparent.—Discovery and extraction of a needle embedded in the hand by means of the Röntgen rays, by M. P. Delbet.—Applications of the method of Röntgen, by MM. C. Girard and F. Bordas.—Extraction of rhodinol from the essence of pelargonium and from essence of roses; identity of these two alcohols, by MM. P. Barbier and L. Bouveault.—On the preparation of silicochloroform, silicobromoform, and on some derivatives of triphenyl-silicoprotane, by M. C. Combes. Silicide of copper, prepared in the electric furnace, and containing 20 per cent. of silicon, is heated in a current of dry HCl to the boiling point of diphenylamine. The liquid obtained consists of silicochloroform (80 per cent.) and silicon tetrachloride (20 per cent.), readily separated by fractional distillation. In this way there is no difficulty in preparing 1 kilo. of silicochloroform at one operation.—Oxidation of crotonic aldehyde, by M. E. Charon. By careful oxidation with silver oxide only one crotonic acid is produced.—The elements of the retina vibrate transversely, by M. A. Charpentier.—On functional assimilation, by M. F. Le Dantec.—A new function of the tubes of Malpighi, by M. V. Mayet.—Some diseases of the potato, by M. E. Roze.—The Hypostomaceæ, a new family of parasitic fungi, by M. Paul Vuillemin. A description of two new parasitic fungi discovered in the needles of Conifers.—On the inversion of the folds on the two sides of the Atlas of Blida (Algeria), by M. E. Ficheur.—On the secondary layers of the provinces of Murcie, Almeria, Grenada, and Alicante (Spain), by M. R. Nicklès.—The Observatory of Mount Argoual (Gard), by M. G. Fabre.

Philadelphia.

Academy of Natural Sciences, February 18.—A paper entitled as follows was presented for publication, "Contributions to the Life-history of Plants, No xii.," by Thomas Meehan. (1) Fecundity of Heliophytum Indicum; (2) origin of the forms of flowers; (3) spines on the Citrus family; (4) flowers and flowering of *Lanium purpureum*; (5) cleistogamy in Umbelliferæ; (6) rhythmic growth in plants; (7) pellucid dots on some species of Hypericum; (8) honey glands of flowers; (9) varying phyllotaxis in the elm; (10) special features in a study of *Cornus stolonifera*; (11) Folial origin of cauline structures; (12) polarity in the leaves of the Compass and other plants; (13) hybrids in nature; (14) origin and nature of plant glands; (15) nutrition as affecting the forms of plants and their floral organs; (16) some neglected studies.—Mr. D. S. Holman exhibited a new stage for the microscope devised for the purpose of studying large objects and widely-spread preparations. It can be adapted to all instruments provided with square stages, and has a motion of two inches each way.—Preparations of minerals containing diatoms in transverse section, and other microscopic arrangements of diatoms prepared by Mr. John A. Schulze, were exhibited by Mr. F. J. Keeley.—Prof. Edw. D. Cope described specimens of fossil reptilia from the Permian and Trias. They belonged to the order Cotylosauria, which had been described by him in 1879, and was afterwards characterised by Seeley from African types. The order embraces the families Elginiidæ, Pariasauridæ, Pariotichidæ, the distribution and characters of which were dwelt on. New genera of Diadectidæ were described under the names Bolbodon and Diatomodon, the teeth of which, as well as of the other genera of the family, were illustrated. The Platodontia may have been derived from the Diadectidæ. The roof over the temporal fossa and the foramen for the temporal eye were illustrated by specimens. The molar teeth of a species of Empedias, the cranium of *Bolbodon tenuitectis*, and the lower jaw of Diatomodon were

exhibited. Another form, described under the name *Conodectes favosus*, may belong to the Diadectidæ, but its relationships are at present uncertain.

Göttingen.

Royal Society of Sciences.—In the *Nachrichten*, No. 4, 1895 (mathematico-physical section) the following memoirs communicated to the Society are published.

October 19.—J. Orth: Report on the work done in the Göttingen Pathological Institute in the summer half-year 1895.

November 16.—W. Schur: Further communications on the results of pendulum-observations in or near Göttingen.

November 30.—Georg Landsberg: Foundations of the arithmetical theory of the algebraic functions of one variable.—Eduard Riecke: The quantities of electricity concerned in a lightning-flash (43 to 98 coulombs).

DIARY OF SOCIETIES.

London.

THURSDAY, March 12.

Royal Society, at 4.30.—The Croonian Lecture: Observations upon Isolated Nerve: Electrical Changes a Measure of Physico-chemical Change: Dr. A. D. Waller, F.R.S.

Mathematical Society, at 8.—On the Enumeration of Groups of Totitives: Prof. Lloyd Tanner.—(1) The Catenary on the Paraboloid and Cone; (2) The Motion of the Top: Prof. Greenhill, F.R.S.

Institution of Electrical Engineers, at 8.—High-Voltage Lamps and their Influence on Central Station Practice: G. L. Addenbrooke.

Society of Antiquaries, at 8.30.

Camera Club, at 8.15.—Lord Armstrong's Experiments in Electric Discharge: Dr. Bowles.

FRIDAY, March 13.

Royal Astronomical Society, at 8.—Observations of the Variable Star R Carinæ, December 1890 to August 1895: J. Tebbutt.—Discovery and Observations of Comet Brooks (*d* 1895); W. R. Brooks.—Observations of the Variable Stars W. X, and Y Sagittarii: Lieut.-Colonel Markwick.—Elliptical Orbit Elements of Comet 1894 *b* (Gale): Rev. T. Roseby.—Results of Double Star Measures at Windsor, New South Wales, in 1895: J. Tebbutt.—On the Determination of the Errors of the Cape Réseau: David Gill and Harold Jacoby.—Royal Observatory, Edinburgh: Observations of Comets.—Note on Mr. Stone's Paper, "Expressions for the Elliptic Co-ordinates of a Moving Point to the Seventh Order of Small Quantities: Prof. E. W. Brown.—Fireball of 1895, November 22: W. F. Denning.—On the Systematic Errors of Measures of Photographic Plates: Prof. H. H. Turner.—Note on the Zodiacal Light as seen at Oxford, 1896, March 4: Prof. H. H. Turner.—Variation of T Centauri: A. W. Roberts.—Royal Observatory, Greenwich: Results of Micrometer Measures of Double Stars made with the 28-inch Refractor in the Years 1894 and 1895.

Physical Society, at 5.—An Addition to the Wheatstone Bridge for the Determination of Low Resistances: J. H. Reeves.—A Communication on Kathode Rays: Herr Puluj.

Malacological Society, at 8.

Institution of Civil Engineers, at 8.—Tests of Centrifugal Pumps: J. C. Cornock.

SATURDAY, March 14.

Royal Institution, at 3.—Light: Lord Rayleigh, F.R.S.

Royal Botanic Society, at 3.45.

Essex Field Club (at Loughton).—Demonstration Meeting.—Mosses and Scale Mosses (Muscineæ): G. M. Holmes and E. D. Marquand.

MONDAY, March 16.

Royal Geographical Society, at 4.30.—On the Maps used by Herodotus: John L. Myres.

Victoria Institute, at 4.30.—Relations of Mind and Body.

Camera Club, at 8.15.—The Faroe Islands: K. Grossman.

TUESDAY, March 17.

Royal Institution, at 3.—The External Covering of Plants and Animals: Prof. C. Stewart.

Zoological Society, at 8.30.—A Contribution to our Knowledge of the Hymenopterous Fauna of Ceylon: Lieut.-Colonel C. T. Bingham.—On British Hydroids and Medusæ: Edward T. Browne.—On some Extinct Fishes of the Teleostean Family Gonorhynchidæ: A. Smith Woodward.

Institution of Civil Engineers, at 8.—The Lixiviation of Silver Ores: J. H. Clemes.—Mining and Treatment of Copper Ore at Tharsis, Spain: C. F. Courtney.—Tin Smelting at Pulo Brani, Singapore: John McKillop and T. Flower Ellis.

Royal Statistical Society, at 5.—Reformatory and Industrial Schools: John Watson.

Royal Photographic Society, at 8.—Screens for Process Work; and a Note on Photogravure: Captain Collardon.

Royal Victoria Hall, at 8.30.—Gold Mining: Dr. T. K. Rose.

WEDNESDAY, March 18.

Society of Arts, at 8.—Bahamas Sisal Industry: Dr. D. Morris, C.M.G.

Royal Meteorological Society, at 7.30.—Weather Forecasts and Storm Warnings: F. Gaster.

Royal Microscopical Society, at 8.—American Rotifera: Dr. A. C. Stokes.

Entomological Society, at 8.—Classification of Three Sub-families of Moths of the Family Pyralidæ: the Epipaschiinæ, Endotrichinæ, and Pyralinæ: George Francis Hampson.—Descriptions of New Oriental Scolytidæ: Walter F. H. Blandford.

THURSDAY, March 19.

Royal Society, at 4.30.

Society of Arts (Imperial Institute), at 8.30.—The Great Landslip at Gohna, in Gurhwal, and the Measures adopted to prevent Serious Loss of Life: J. H. Glass, C.I.E.

Linnean Society, at 8.—On the Scructure of the Female Flowers and Fruit of Sararanga, Hemsl (Pandanaceæ): Dr. A. Stapf.—On Two Little-known Opisthoglyphous Snakes: G. S. West.

Chemical Society, at 8.—The Constitution of a New Organic Acid: H. J. H. Fenton.—The Volume and Optical Relationships of the Monoclinic Series of Double Sulphates $R_2M(SO_4)_2.6H_2O$: A. E. Tutton.

Society of Antiquaries, at 8.30.

Camera Club, at 8.15.—Views in Cashmere: G. Millais.

FRIDAY, March 20.

Royal Institution, at 9.—Immunisation against Serpents' Venom and the Treatment of Snake-Bite with Antivenene: Prof. T. R. Fraser, F.R.S.

Epidemiological Society, at 8.—On Puerperal Mortality: a Statistical and Etiological Inquiry: Dr. Williams.—An Outbreak of Typhoid Fever in Beyrout, Syria: Dr. Wortabet.

Quekett Microscopical Club, at 8.

SATURDAY, March 21.

Royal Institution, at 3.—Light: Lord Rayleigh, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—By Meadow and Stream: The Amateur Angler (S. Low).—Intensity Coils, 17th edition (Perken).—Alternating and Interrupted Electric Currents: Prof. G. Forbes (Biggs).—Physical Units: Dr. M. Maclean (Biggs).—Hypnotism, Mesmerism, and the New Witchcraft: E. Hart, new edition (Smith).—Les Fermentations: P. Schützenberger, sixième édition (Paris, Alcan).—The New Photography: A. B. Chatwood (Downey).—The Story of the Nations: The West Indies and the Spanish Main: J. Rodway (Unwin).—Leçons sur la Cellule, Morphologie et Reproduction: L. F. Henneguy (Paris. Carré).—Mechanics for Beginners: W. Gallatly (Macmillan).—The Number Concept: Dr. L. L. Conant (Macmillan).—An Elementary Treatise on Rigid Dynamics: W. J. Loudon (Macmillan).—Electric Wiring: R. Robb (Macmillan).—Griffin's Electrical Engineer's Price-Book, new edition, Edited by H. J. Dowsing (Griffin).

Pamphlets.—Zur Mechanik des Vogelfluges: Dr. Fr. Ahlborn (Hamburg).—Preliminary Report on the Tsetse Fly Disease, or Nagana, in Zululand: Surgeon-Major D. Bruce (Durban).—How to Assist the Sight (J. H. Steward).

Serials.—Bulletin of the American Mathematical Society, February (New York, Macmillan).—Geographical Journal, March (Stanford)—Journal of the Royal Microscopical Society, February (Williams).—Psychological Review, Monograph Supplement. No. 2. Association: M. W. Calkins (Macmillan).—Science Progress, March (Scientific Press).—Revue de l'Université de Bruxelles, Nos. 1 and 2 (Bruxelles).—Proceedings of the Physical Society, March (Taylor).—Engineering Magazine, March (Tucker).

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THURSDAY, MARCH 19, 1896.

THE PHYSIOLOGY OF THE EXCITABLE TISSUES.

Elektro-physiologie. Von W. Biedermann, Professor der Physiologie in Jena. Zweite Abtheilung. Mit 285 Abbildungen. Pp. 441 to 857. (Jena: Fischer, 1895.)

THE second volume of Prof. Biedermann's work, now before us, fully maintains the reputation of its author, and is, if anything, still more interesting than the preceding volume dealing with muscle.

This additional interest, though due in some measure to the subject-matter, embracing, as this does, the fundamental excitatory phenomena of nerve, the functional activity of electrical organs of fishes, and the electromotive phenomena of plant and glandular structures, is aroused and maintained by the evident drift of the writer towards a full expression of those views which he is known to share with Prof. Hering, and which the present volume affords him an opportunity of enunciating.

Such an exposition of the mental attitude of the present occupant of the Leipzig chair of Physiology (Prof. Hering), in regard to the play of those vital processes whose physical manifestations are the objects of the physiologist's investigation, is of the highest importance, since it is well known that the influence of this conception upon the physiological science of to-day is as great as was that of Hering's distinguished predecessor, Prof. Ludwig, on the science of a few years back.

The clear account here given of the two aspects of physiological change, association and dissociation, and their relation to the physical aspects of vital phenomena, is further increased in value by its setting. Placed at the end of the chapters on nerve, in that devoted to the theoretic views as to the electromotive phenomena of this structure, the author, adopting the historical method, leads up to Hering's theory through the earlier molecular theory of Du Bois Reymond and the very differently conceived theory of Pfluger, both of which rest upon a mechanical scheme as their basis, and the author then shows to what an extent the views of these two writers paved the way for that which he proceeds to present in Hering's words. Perhaps no more striking testimony to the universal character of the present acceptance of this latter view, could have been brought forward than the theory of Bernstein, the exposition of which follows that of Hering, since it brings into prominence the modifications in Hering's sense, which even such a staunch adherent of the molecular theory as the Hallé Professor has felt it necessary to elaborate.

The position here taken up by Prof. Biedermann is held by him to be the only one at present capable of embracing within its scope all the various phases of excitatory change, and its tenability is supported by an array of fundamental reaction phenomena, many of which have been ascertained by his own researches.

An interest of a very special kind is thus given to the description of the characters of the excitatory effects in nerves.

Such, for instance, is the experimental comparison between the circumstances which condition the excitatory effects produced on the opening of a galvanic current which has been led through a nerve. The initial, suddenly-developed, and comparatively short-lived muscular response to the opening nerve excitation (opening twitch) is shown to be essentially dependent upon a preceding constrained state of greater inexcitability (theoretically, *association*), and, as it is brought about by the removal of the constraining agent (the galvanic current), may be considered as a *dissociation* rebound from this condition. It is contrasted with a second more slowly developed and more lasting excitation, evoking in the muscle an opening tetanus, the essential productive factor of which is a preceding state of greater excitability (*dissociation*), a latent excitation now rendered kinetic in consequence of the slight additional dissociation effected by such a rebound. The play of different conditions upon the two effects is brought into prominence by the description of some most striking experiments, in which one is affected to the exclusion of the other by means of a special environment.

Such, again, is the description of the response evoked by nerve excitation in the muscles which respectively open and close the claw of the crayfish, a response which may be either the well-known contraction or a less familiar muscular relaxation (inhibition); experimental results which probably find their parallel in the well-known effects produced in cardiac muscle by excitation of the vagus nerve.

The excitatory electromotive changes localised to the neighbourhood of the poles when a galvanic current commences or ceases to flow through a nerve, the distinction between the vital reaction phenomena and the physical polarisation phenomena in special relation to the production of the extrapolar electrotonic currents, the specific reactions of etherised and of cooled nerves, the effect of different saline substances upon these reactions, are but a few of the many pertinent examples brought forward, the concise, clear statement of which renders the present volume such a valuable contribution to physiology.

It is perhaps to be regretted that the arrangement of subject-matter adopted by the author has involved the necessity of grouping such a large number of phenomena under the heading "Die elektrische Erregung der Nerven," with the result that this enormous chapter is 100 pages long. We venture to think that this portion might with advantage have been split into several subsidiary sections. A very large part of the present knowledge of nerve activity has been obtained by the use of electrical methods of excitation, and a vast amount of work has, in consequence, been carried out upon this aspect of the question. It is, therefore, an almost herculean task to set forth in unbroken continuity all the phenomena which fall within the scope of this title, and to do so without running the risk of making such narration wearisome to the reader, and annoying to the reference student who seeks information on one particular group of such phenomena. Prof. Biedermann has run this risk, and it cannot honestly be said that he has succeeded in avoiding the danger. As it stands at present, this chapter, although teeming with interesting details, because of this very fecundity, may not impossibly cause the reader to agree, during its perusal, with the remark

of Shakespeare's tinker listening to the play of *The Taming of the Shrew*:

> "'Tis a very excellent piece of work, madam lady,
> Would 't were done!"

We also venture to criticise the position which has been assigned by the author to the electromotive phenomena of plants. As a concise account of the present state of knowledge on the subject, this chapter is excellent; but we doubt if it is wise to place this apparently simple but really difficult branch of Electrophysiologie at the commencement of the volume. It is calculated to raise false hopes, and give the reader the impression that the phenomena in question form an easy prelude to those of nerve, which form the staple material of the work; and this, it need hardly be said, is by no means the case. The section on the electrical organ fitly follows that on the electromotive changes in nerve, and is an admirable one. If we are not mistaken, this portion occupies a unique position, since it is the first attempt to give a complete scientific account of the special functions of all known electrical organs. The excellence of the treatment is undoubtedly due to the evident necessity felt by the author to treat the subject *ab initio* from many points of view, yet to always tend towards one goal—that of explaining the nature of the specific electrical activity involved. To secure this, the section is far more amply illustrated than the others, and the illustrations themselves are extremely well chosen, whilst the hold upon the reader is strengthened by the description of the structure of the organ and of its nervous connections in the different fishes, and by the excellent woodcuts which portray the chief histological features.

It may be confidently asserted that no book has yet appeared, dealing with the fundamental phenomena of the excitable tissues, which can be compared with the volumes of Prof. Biedermann. The wealth of experimental data alone must stamp the work as one which for many years will be not merely read by advanced students, but consulted as a reference book, and it thus worthily takes its place in this highest rank of scientific treatises. It is with pleasure, therefore, that we anticipate its translation, in the belief that its appearance in an English dress will, by making it more accessible, confer a boon on all those in this country who take a special interest in physiology.

F. Gotch.

TAXATION.

Essays in Taxation. By E. R. A. Seligman, Columbia College, New York. Pp. 424. (London: Macmillan and Co., 1895.)

PROFESSOR SELIGMAN is one of the few economists that have influenced the politicians. The Tax Commission of Ohio made use of his book on "Shifting and Incidence of Taxation" (1892), and confessed they were not able to make full acknowledgment of the debt lest they should give their report too academic an appearance! ("Essays," p. 415.) Every one who reads Mr. Seligman's books will feel the reason of their influence; there is a firm grasp of principles; there is a close contact with facts; there is a constant testing of the one by the other.

The "Essays" were written in the first instance for Americans, and the illustrations are largely drawn from America. But the reasonings are of general application, and are more or less fully so applied. We need not dwell on the earlier part of Mr. Seligman's historical survey. Logic and experience, he thinks, conspire to show that not property, or even expenditure, but "income or revenue" is the best measure of ability to bear taxes (p. 18, *cf.* 21), and the world at large is slowly coming round to this conclusion.

> "To arrange a system of taxation which shall, on the whole, correspond as closely as possible to the net revenues of individuals and social classes, and which shall take into account the variations in tax-paying ability, has thus become the demand of modern civilisation" (pp. 21, 22).

It has taken a long time to sift out and reject the wrong systems, and, as we might expect, there is a singular correspondence between one nation and another in the progress through blunders. For example, the General Property Tax, condemned by theorists and confessedly unsuccessful on the other side of the Atlantic, is by no means peculiar to the United States. It was not a blunder at first, and only becomes so when perpetuated. It is that form of taxation which is suited to a society

> "where the only property is the collective indivisible property, where the landowner and capitalist are one. There is one kind of property, and therefore only one kind of property tax. But, as soon as property is split up into different parts, as soon as there are various kinds of property, just so soon does the single property tax become antiquated and useless. It is not only useless, but it is now absolutely iniquitous. For the attempt to include under one head the gains flowing from widely different pursuits . . . can end only in the virtual exemption of the new forms, and a consequent overburdening of the old" (p. 38).

In the Middle Ages it was for some time the prevailing tax, and was then quite fair because there was little differentiation of property (p. 46).

> "History everywhere teaches the same lesson. As soon as the idea of direct taxation has forced itself into recognition, it assumes the practical shape of the land tax. This soon develops into the general property tax which long remains the index of ability to pay. But, as soon as the mass of property splits up, the property tax becomes an anachronism" (p. 53),

and the property tax reverts to real estate. The property tax in the United States is therefore "not an American invention, but a relic of mediævalism." In our times all kinds of property are not equally productive; property is not a sure criterion of individual gains; and there remains the consideration of the individual's indebtedness, suggesting the need of taxing him not on his property, but on his clear assets (p. 60). The General Property Tax can be evaded by every one except a bank shareholder (pp. 147, 148). Practically, as now levied in the States, "it is one of the worst taxes known in the civilised world" (p. 61). Mr. Seligman has an English frankness in dealing with the faults of his native country.

The Single Tax (chap. iii.) on the land escapes no better. Our author rejects it both on theoretical and practical grounds; and he says all that needs to be said on the

matter, though this field has been often traversed, and there is less scope for his originality. He shows us

"that it would be inelastic, and that it would intensify the inequalities resulting from unjust assessments; that, although proposed chiefly from social considerations, it would prevent the Government from utilising the taxing power for other social purposes, and that it would divorce the interests of the people from those of the Government; that it would offend against the canons of universality and equality of taxation, and would seriously exaggerate the difference between profits from land and profits from other sources; and, finally, that it would be entirely inadequate in poor and new communities, that it would generally have an injurious influence on the farmer, and that even in the large urban centres it would exempt large sections of the population without bringing any substantial relief to the poorer classes" (p. 93).

We have in this book what the title of it leads us to expect—a series of detached essays, and not any connected series of arguments, growing one out of another like the chapters of a book. There is nothing but a play of words, for example, to make "Double Taxation" follow the "Single Tax," for single and double are not used in the same senses in the two cases described. Perhaps the most important discussion in the chapter on "Double Taxation" is that on the taxation of aliens. Seligman considers that the principle of economic interest should be the guide here. We should find out from what place an individual gets his income, and in what place he spends it. "Only in this way can his real economic interests be located" (p. 111). The question is even more difficult in the United States than here, for members of different States are financially foreigners, and even the relations of Scotch law to English law do not quite help us to understand the relations of (say) the laws of New York to those of California. In the case of the United States among themselves, seeing that there is no real political severance, it ought to be easy to accept "economic allegiance as against the antiquated political allegiance" (p. 110). But between the United States as one unit, and Canada as another, for example, a critic might observe that such a view will not so readily find acceptance.

After a short chapter on inheritance taxes, we come to the taxation of corporations, or, as we should say, companies. Mr. Seligman here, as elsewhere, makes very effective use of the Swiss Federation and its difficulties as a European parallel to the case of the United States (p. 248). On the subject generally, perhaps his most striking contention is that the bonds and loans of companies should be taxed as well as their stock and shares, since the bonds and stock together form the working capital of the company, from which the said company derives its income. He thinks that in the case of an individual, on the other hand, interest on debt must be deducted from income, or else there will be double taxation (pp. 214, 215, &c.). This is one of the few cases where he does not produce conviction. The conclusion would more naturally be that all money borrowed to carry on or extend business may be included in the borrower's capital, whether the said borrower be an individual or a company.

After these essays on particular taxes comes a "Classification of Public Revenues" (chapter ix.), which might have been better placed at the beginning of the book. It brings out the author's favourite distinction of fees from taxes. There is a good chapter on the "European literature" about taxation. The author's wide knowledge of it makes us surprised at his inacquaintance with Grote's remarks on Greek taxation (see p. 85, note).

English readers will find little to criticise in Prof. Seligman's account of the Betterment Tax (embodied in the Tower Bridge Act of 1895), and Sir William Harcourt's Finance Act of 1894. Surely, however, the Professor is wrong in supposing that we have no special assessments on landlords (p. 312). They are certainly under obligation to pay for the making of the roads in front of their property; and his description of "special assessments" fits their case exactly. Perhaps the distinction of these assessments from fees is less strongly marked than Mr. Seligman thinks; they are at least species of the same genus.

The language of the "Essays" is excellently suited to the subject, and there is no waste of it. It is just possible that love of antithesis is occasionally a snare to the writer.

"In the case of the private business the monopoly [monopolist?] seeks only the greatest possible profits; in the case of the public monopoly the Government seeks the greatest possible public utility" (p. 296).

If this were so, France would be proverbial for the excellence of her tobacco.

In a new edition perhaps the arrangement might be improved, and possibly the lesser book on "Shifting and Incidence" incorporated, so as to make the whole a connected treatise on taxation with more evident order and connection of parts. Till Mr. Seligman has done this for his book, it will not produce on the general public the impression to which its high merits entitle it.

OUR BOOK SHELF.

Handbuch der Mineralchemie. Von C. F. Rammelsberg. Zweites Ergänzungsheft zur Zweiten Auflage. Pp. 475. (Leipzig: Engelman, 1895.)

NO fewer than fifty-five years have passed since the author issued his "Dictionary of the Chemical Part of Mineralogy," and yet his energy is unabated. The present work is the second supplement to the second edition (1875) of his well-known "Handbuch der Mineralchemie," a treasury of condensed information relative to the results of the chemical analysis of minerals, and the supplement is a concise record of chemical work on minerals published during the last decade. As in the original treatise, the author restricts himself to the expression and criticism of observed facts, and avoids as far as is possible the discussion or even mention of constitutional formulæ. And for the purposes of the student it is doubtless convenient to have collected for him into a single treatise the observed solid facts upon which all speculation relative to the chemistry of minerals is to be based. Once more the mineralogical chemist is reminded how rarely the analysed material is truly pure, and how necessary it is to record its morphological and physical characters, the mode of its occurrence, and the nature of the accompanying minerals: it is only by regard to such records that the true composition of a mineral can in many cases be deduced. And the author points out how imperfect is our knowledge of the chemical composition of many of the commonest minerals notwith-

standing the number of analyses which have been recorded. In the case of the plagioclastic felspars, for example, though the results of many analyses are in close agreement with the hypothesis of the admixture of molecules of albite and anorthite, there are others which deviate considerably therefrom, and are as yet unexplained. The caution of our chemical Nestor is perhaps carried to an extreme. He declines, for instance, to recognise the interchangeability of F and HO, notwithstanding the results independently obtained of each other by Penfield and Sjögren in the case of the Humite group, and by the former in the case of Topaz, and attributes the variations of composition to alteration—to loss of fluorine and gain of water. But in the case of Topaz the angle of the optic axes has been shown to be related to the percentage of the fluorine, and it is difficult to regard the variation of chemical and optical characters to be a result of mere hydration. Every one will hope that the Berlin professor will be spared to issue a third supplement of this standard work of reference. L. F.

Elements of Botany. By J. Y. Bergen, A.M., Instructor in Biology, English High School, Boston. Pp. vi + 275 + 57. (Boston, U.S.A., and London: Ginn and Co., 1896.)

IT is very seldom that we have come across an elementary book on botany which has impressed us so favourably as the one now under review. It is intended primarily for school use, but the admirable method which is maintained throughout its pages ought to be practised in all grades of class work. A general account is given of the simple morphological and physiological phenomena of plant-life, and the student is encouraged to put the knowledge thus acquired in each section to a practical test. A selected object or experiment is indicated to him, and he is shown how to put his own questions. He is *not*, however, told the answer—that he has to find out for himself as the result of independent observation.

The work is well illustrated with more than 200 figures, and contains, besides, appendices on material and methods, a useful chapter of about fifty pages on the commoner orders and species of flowering plants inhabiting the northern and middle States.

Although the author has naturally paid special attention to the needs and opportunities of American students, his book ought to be well received in this country also, for most of the plants mentioned are readily obtainable here, and from an educational standpoint the book is quite one of the very best we have met with.

Geology. By C. L. Barnes, M.A., F.G.S. Pp. viii + 181. (London: Rivington, Percival, and Co.)

THIS is not a very remarkable addition to the already large number of easy books on geology. When we have said that the volume is readable, and a suitable one to put into the hands of beginners, we have uttered all that is demanded by the text. The illustrations are the least attractive features of the book; none of them are striking, and few, if any, of them are new. A fact to which attention may well be directed, is that the book does not follow any examination scheme.

The New Photography. By A. B. Chatwood. Pp. 128. (London: Downey and Co., 1896.)

THE "new photography" described in this book is not confined to work with Röntgen rays, but includes also accounts of colour photography, psychic photography (retinal impressions) spirit photography, and anaglyphs. The book is, to say the least, a trifle premature as regards work with Röntgen rays; and the title, as well as the shadow of the bones of a hand, printed upon the title-page, is misleading as to the contents.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dr. Ball's Two Letters on the Ice Age.

SIR R. BALL'S last letter is a little embarrassing for those who have accepted his teaching. In it he claims that however faithless his other supporters may have proved, he can still rely on the countenance of Dr. Wallace. What does it all mean? Dr. Wallace is responsible for a theory of the Glacial period which has been before the world for many years, and which is entirely different both in essence and in its consequences from that proclaimed in "A Cause of the Ice Age." Are we to understand that Sir R. Ball has adopted Dr. Wallace's theory, or is it Dr. Wallace who has adopted Dr. Ball's? The differences between us are so important in view of modern geological conclusions, that I may be perhaps permitted to condense a few simple issues in a few questions. I could add more if necessary.

Sir R. Ball says he has not changed his views. Does he still then hold, as he once did, that astronomical causes alone will suffice to produce an Ice Age, or does he now hold with Croll and J. Geikie and Dr. Wallace that they will not, and must be supplemented by other causes?

Does he still maintain, as he maintained in the new edition of his book, the old-fashioned theory as to the laws of radiation, or does he believe in Stefan's law, which entirely alters the whole basis of the case, both as taught by himself and by Croll?

Does he still maintain that the Kabbalistic figures 63 and 37, which represent a constant and invariable factor, whatever variations there may be in the eccentricity of the earth's orbit, and which therefore cannot induce variability of climate, are not only the efficient element in producing an Ice Age, but represent, as he states in his work, the proportions of summer and winter heat received in the latitude of Britain either now, or at any time?

On page 27 of the same edition Dr. Ball says: *Our hemisphere was once covered with ice.* Does he still maintain this, the most extravagant doctrine ever propounded by a Glacialist?

In his first letter to you, Dr. Ball admitted that Mr. Culverwell's calculation of the distribution of the sun's heat over different zones of the earth at present, and during the period of extreme eccentricity, is unassailable, but that the result is affected by convection of heat from other places. How does he reconcile this view, which was Croll's, and is also Mr. Culverwell's, with any part of the argument in his book, which was written, as he says, to enable us to dispense with other than astronomical causes?

Lastly, Sir R. Ball professes to account for *the* Ice Age—that is, the Glacial period of the geologists. In doing this he contrasts the effects of present eccentricity with the effects of the limit of *extreme eccentricity* as calculated by Leverrier and Stockwell. Does he seriously argue that the great Ice Age took place 850,000 years ago? As he well knows, we must go back to that period before we get a disparity of the seasons amounting to thirty-three days, and any time during the last 300,000 years, this disparity has been always very much less. Is it either ingenuous or right to treat this extreme variation as a factor in any possible range of speculation on the Ice Age?

As I said, I could add largely to these issues; but they will suffice. The matter is not a private difference of opinion. It is one upon which the basis of a great deal of geological reasoning must be founded. HENRY H. HOWORTH.

30 Collingham Place, Earl's Court,
March 11.

The Röntgen Rays.

So many people are buying tubes for the "new photography," that I think it ought to be made known that the best results can be obtained with the original spherical tube used by Prof. Crookes in 1879, to show the incandescence of platinum under impact of the projected molecules which were focussed on it by a concave kathode. I have been using such a tube for my best work up to now. On January 29 last, I put in hand a larger tube of the same kind, with the same large concave kathode at the top and small disc anode at the bottom, but without the platinum in the middle. This tube is six inches in diameter. But the tube-makers have been so occupied with smaller tubes,

which are far less trouble to make, that it was only sent me yesterday. I at once used it to photograph a man's hand on an inverted celluloid film, the whole enclosed in a black bag in the usual way. With five inches of spark, and an exposure of three minutes at eight inches distance from the film, I obtained fine definition of the bones as far as the film went, including the junction of the two bones of the arm with the wrist. No Tesla apparatus was used. Had it been, doubtless the exposure could have been considerably shortened. An area of twelve inches by ten inches was covered perfectly. The tube was then set on for thirty minutes without stopping with a ten-inch spark coil, and showed no perceptible heating.

Although the definition was even better, the original tube with the platinum required an exposure of ten minutes under the same conditions.

I should like to draw attention to a curious dark shadow, which appears to be hanging in mid-air just above the anode, when the six-inch tube is set in action, and persists for some time afterwards. This shadow has the appearance of an ovoid dark space surrounded by a halo, and is probably the shadow of the kathode. Is it possible that rays proceed from a spot coincident with this shadow? A few rough experiments I have made, seem to lend colour to this view.

Chard, March 8. J. WILLIAM GIFFORD.

I SEE from a note in last week's NATURE, that some little doubt has been thrown upon the practical value of Röntgen's discovery in surgery. The following notes may therefore be of some interest.

With regard to the cryptoscope—after trying a number of substances, I have fallen back upon potassium or barium platinocyanide for the screen; the potassium salt was suggested to me, and I find the shadows show up in some respects better. The special form of cryptoscope which I have made is binocular, and with a good Crookes' tube I have had excellent results. I have been able to see distinctly shadows of the whole of the bones of the upper extremities, and a good portion of the lower; but what is most interesting, I have been able to look straight through a skull into which I had placed two or three bullets, and had no difficulty whatever in seeing shadows of them, although somewhat enlarged.

With regard to the photography—I have photographed the inner table of the cranium, the upper part of the spine in the neck, and half the spine and vertebræ in an adult. Not only have I got shadows, but distinct images of the surface of the bones of the spinous and transverse processes of the vertebræ; the ribs being particularly well defined. I have also photographed all the joints in the body with two exceptions, and this for the simple reason that I had not time to do them.

For practical purposes exposure is of importance. Fortunately the movable parts, such as the extremities, are more easily photographed than the denser and thicker tissues of the trunk. In other words, where we require quick exposures the conditions are more favourable.

I believe the Röntgen photography, and the cryptoscope, will prove to be one of the most valuable discoveries ever placed before us. JOHN MACINTYRE.

179 Bath Street, Glasgow, March 16.

WHILE a Crookes' tube discharges an electroscope charged with positive or negative electricity, when negative most rapidly, I have found with several of the ordinary spectrum tubes, particularly one containing oxygen, and another hydrogen, that these tubes produce the Röntgen rays, but act differently upon a charged electroscope. When the charge is positive, the leaves collapse immediately; when negative, they open out still further.

With the spectrum tube containing oxygen, good impressions have been obtained upon a photographic plate in four minutes.

London, March 16. F. J. REID.

The Huxley Memorial.

SINCE last a public announcement was made, the names of Sir H. H. Johnston, K.C.B., H.M. Commissioner and Consul-General in British Central Africa, and of Mr. Charles Hose, resident magistrate at Sarawak, have been added to the General Memorial Committee, which now numbers considerably over 700 persons, representative of science, literature and art, in all parts of the world.

The amount promised and received now exceeds £2300, and as a sufficient sum is thus guaranteed for the statue at the British Museum of Natural History and the medal at the Royal College of Science, London, the first two objects of the Committee definitely decided upon, Sub-Committees have been appointed to carry these objects through, and designs for the statue are now being prepared by Mr. Onslow Ford, R.A.

Appeal is now being made for the third object of the Committee, viz. "the furtherance of biological science in some manner to be hereafter determined, dependent upon the amount collected." The foundation of exhibitions, scholarships, or lectureships has been proposed, and for this purpose a considerable sum will be required. The efforts of the Committee to raise this are being promoted by the organisation of Local Committees in all parts of the world. Conspicuous among the results already obtained by this means is the receipt of £25 from the town of Leicester, through the mediation of its Literary and Philosophical Society; and it is hoped that this may be taken as a criterion of expectation from other localities. Donations of any amount will be gladly received by the Hon. Treasurer, Sir J. Lubbock, Bart., or by the Bankers, Messrs. Robarts, Lubbock, and Co. (15 Lombard Street, E.C.), or by myself.

A circular is now printed for distribution in lecture-rooms and elsewhere, and I should be very glad to communicate with friends or admirers of the late Prof. Huxley, or with persons connected with societies or institutions, who may be willing to aid the Memorial Committee by distributing copies of this letter or in any other manner. G. B. HOWES,

Hon. Sec. Huxley Memorial Committee.

Royal College of Science, South Kensington, March 17.

Natural History Museum.—Bird Gallery.

MAY I ask when the "common people" Mr. R. B. Sharpe speaks of in your issue of February 20, will "have the opportunity to read, mark, learn, and inwardly digest what the Museum is trying to teach"? As regards the Bird Gallery, the "opportunity" seems to be no nearer than it was fourteen years ago. Surely there has been time during that period for the preparation of a "guide" for the Bird Gallery, equally with the Shell and various other departments. *All* the "common people" can learn at present, is the scientific and, in some cases, the popular name of the bird, and its habitat. Among the thousands of species exhibited, there must be many whose history, written in a few lines, as is done with the British specimens in the table-cases, would be both interesting and instructive. I may add that there is no "guide" to the Department of British Zoology.

E. S.

The Aurora of March 4.

THE fine auroral display, noticed in NATURE, March 12, pp. 437 and 444, was brilliantly visible from the streets of Dublin at 8 p.m. on March 4. The great beam, rising from the characteristic bank of cloud into a starry sky, originated due west, and, if continued, would have passed to the south of the zenith. At 8.5 three or four short parallel rays, resembling a gridiron, appeared in a patchy way some 20° to the north, in a similarly clear sky; they disappeared rapidly, and five similar parallel bars arose close to the north side of the main ray at 8.10. At 9.30 the display had faded, as far as the city was concerned. GRENVILLE A. J. COLE.

Royal College of Science for Ireland.

Inverted Images.

MANY years ago I tried the method of reading a book upside-down on people who had never consciously attempted it before. I was surprised at the very great difference of aptitude. Generally individuals who had clear recollections of form, and could reproduce sketches of what they had seen more or less correctly, read easily and at once; but the greater number read slowly, frequently spelling as they went along. A boy of nine years of age, who was in the habit of reproducing on paper, with scissors, horses, dogs, cats, coaches, &c., read upside-down at once. I noticed that in cutting his patterns he sometimes cut his horse upside down, but more frequently the normal way. The same

boy, in demonstrating geometrical propositions, was not the least put about with the reversal of the diagram. He afterwards turned out a clever pattern-designer. JAMES SHAW.

The Age of the Wealden.

IN a letter in NATURE for March 12, Prof. Marsh calls attention to the evidence of the vertebrate fauna of the Wealden rocks as being in favour of including that series in the Jurassic system.

It may be of interest to add that a recent examination of an exceedingly rich collection of fossil plants obtained by Mr. Rufford from the Wealden rocks near Hastings, and now in the British Museum, leads very decidedly to the same conclusion. Between the Wealden flora of the South of England, in which no traces of undoubted Angiosperms have so far been found, and the typical Jurassic plants from the Yorkshire coast, there is a very close resemblance. A. C. SEWARD.

Cambridge, March 16.

The Stress in Magnetised Iron.

DR. CHREE will meet, I think, with general support in his opposition to the view that there is of necessity, or even usually, an actual stress in a magnetised rod tending to shorten it; but in maintaining, as I understand him to do, the opposite view that the magnetic tension along the lines of force is necessarily accompanied by a mechanical stress of pull and the associated extension, he appears to me to be on more disputable ground. Dr. Chree's conception of the Maxwell distribution of stress seems, if I may venture to say so, to be too materialistic. What Maxwell really showed, of course, was that such a distribution would produce on every element of matter in the field the mechanical force which it was known actually to experience. It was not suggested, however, that these stresses were to be considered as transmitted by the matter by virtue of its mechanical properties, indeed this could clearly not be the case where the matter was liquid or gaseous; and so there are no grounds for supposing that the matter would exhibit strains directly associated with these stresses. The stresses, in fact, must be considered as transmitted by the ether which pervades the field, and it is in the ether that the associated strains are to be looked for.

If, however, we turn our attention from the ether to the matter in the field, and remember that certain portions of this matter will in general be experiencing mechanical forces, we see that if its equilibrium is to be maintained a suitable system of mechanical stresses and the associated strains must be set up in it.

In the case considered by Dr. Chree in his letter to NATURE, published on January 23, it is plain that if AA′ and BB′ are air-gaps, and are not filled up with a material capable of offering resistance to longitudinal compression, the portions A′ and B′ of the bar must be held or fixed in some way if there is to be equilibrium. This was pointed out by Prof. Ewing, but Dr. Chree does not seem to have appreciated its significance, and his disregard of the external forces required for this purpose is responsible for the apparent discontinuity to which he refers in his second letter. If A′ and B′, with these forces applied to them, are allowed to move up to A and B so as to close up the air-gaps, we pass without discontinuity to the case of a magnetised rod under external pull, and thus in a state of mechanical tensile stress and elongation. If now we consider these external forces to be gradually diminished to zero, and suppose that the question is not complicated by end effects at the outer ends of A′ and B′ (as it will be in the case of a straight rod unless external forces are kept applied at these ends), the mechanical tensile stress and elongation will diminish to zero also, and we have passed without discontinuity from Dr. Chree's result to Prof. Ewing's.

That Dr. Chree has obtained the correct result for the special case which he investigates, appears from the following considerations. Assuming that AA′ and BB′ are equal air-gaps, and that A′ and B′ are fixed, AB will be in equilibrium. The Maxwell distribution of stress gives equal mechanical forces on the surfaces A and B directed outwards, and consequently there will be tensile mechanical stress in AB with its associated extension. In this case, therefore, there is actual elongation of the metal in the direction of the lines of force. In the case of an endless ring, however, the Maxwell distribution of stress gives no mechanical force, and no mechanical stresses with associated strains will be set up. This is the case considered by Prof. Ewing, who obtained the same result. I must confess that I do not follow Dr. Chree's objections to Prof. Ewing's reasoning on this point. The mechanical stresses must be such that every portion of the ring is in equilibrium. Prof. Ewing does not complain that tensile stress in a ring is unimaginable, but that it does not comply with this condition. If Dr. Chree will reconsider his reference to the case of a rotating anchor ring, he will admit, I think, that as every element of such a body is not in equilibrium, but in accelerated motion, the fact that tensile stress can and does exist in it is not relevant.

As a further illustration of the variety of the mechanical actions which may accompany the Maxwell distribution of stress, we may consider the case of two sheets of tinfoil placed against opposite faces of a plate of glass and maintained at different potentials. It is readily seen that in this case the glass undergoes a mechanical stress of compression and the associated strain of shortening in the direction of the lines of electrostatic force, though the Maxwell stress in this direction is a tension. L. R. WILBERFORCE.

Cavendish Laboratory, Cambridge, February 26.

RECENT WORK OF THE GEOLOGICAL SURVEY OF THE UNITED STATES.[1]

II.

SINCE Gilbert (in 1887) published his classical monograph on the geology of the Henry Mountains, in which he gave to the world for the first time a clear and connected account of the nature and occurrence of Laccolites, we have waited many years for further original work on this type of physical structure in America. A study of the writings of Peale, and of the exquisite panoramic drawings of Holmes, made it abundantly clear that laccolitic masses must be frequent in the United States. Mr. Whitman Cross has now collected a number of instances from Colorado, Arizona, and Utah.[2] He has remarked on their structure so far as it has been made out by these observers, by Emmons, and by himself, given a description of the characters of the rock of which the laccolites consist, and offered some remarks on the general theory of laccolitic structure.

The theory has not been quite so fertile in results as might have been expected from the clear-cut nature of Gilbert's brilliant piece of work; nevertheless the author is able to show that, although Reyer refuses to accept the facts on which the theory is based, Suess, on the other hand, reproduced the illustrations, summarised the results of Gilbert, Peale, and Holmes, and applied them to European and other examples, while Neumayr added further arguments in favour of the intrusive nature of the Henry Mountain rocks themselves. It may be pointed out here that the existence of laccolites has been taken almost for granted by many British authors (not referred to by Cross), such as Kinahan, Geikie, Harker, Marr, and others, and that in one case at least a numerous group of laccolites has been described, and proof given that the igneous masses are conformably underlain and overlain by sediments.[3] The abstract of this paper, all that was published for many years, also anticipates some of the conclusions independently reached by Mr. Cross.

The familiar Henry Mountains are first described, then the West Elk Mountains to which attention was drawn by Peale, and in succession the San Miguel, La Plata, Carriso, El Late, Abago, and La Sal Mountains. All these are either on the verge of the great plateau, being thus geographically outliers of the Colorado Mountains, or they are isolated groups on the plateau itself. They are groups of laccolites intruded into nearly horizontal strata probably at about the same period—in Tertiary

[1] Continued from page 441.
[2] "Fourteenth Annual Report of the Geological Survey of the United States," 1892-93. (1894.)
[3] "Report of the British Association," 1886.

time, as they pierce rocks of Cretaceous age. The Mosquito Range of central Colorado, and the Ten-Mile district to the west of it, were studied by Jacob and Emmons, and in these areas intrusive rocks of the same composition occur as laccolites, sills, and dykes in more ancient rocks, and even in the fundamental Archæan complex. A few other cases are referred to.

The study of these examples reveals the fact that the theory has received several important accessions, and even some modifications. The laccolite is beginning to lose the familiar mushroom shape which, with its central stalk, has done much to cause incredulity; we find, instead, excentric dykes and pipes, complex groups of dykes, even sheets and dykes in suspicious proximity to important faults, indicated as the feeders of the lens-shaped masses of igneous material; this gives much more of structural verisimilitude to the type. Again the masses are shown to be more often irregular or unsymmetrical in outline, faults as well as folds give easement to the lifted cover, the so-called pine-tree laccolite, or group of anastomosing sheets is not infrequent; bunches of laccolities irregularly intruded into yielding shales take the place of the single "stone cistern," and the laccolite is sometimes shown to cross the strata both above and below. In addition to formal sections, many of the beautiful outline and panoramic sketches of Holmes are reproduced; these are drawn with such a wonderful feeling for the run of the country, that the igneous structure can often be made out from them alone. In fact, so much has been made out of what material has been already got together, that we feel bound to express a hope that selected examples of the group will shortly be mapped out in detail by the skilled stratigraphers of the Survey, in order to ascertain in such a favourably exposed region what is the precise relation of laccolitic groups to the folding of rocks, and the exact part played by them in tectonic history.

It is a remarkable fact that the rock in the laccolites is almost uniform in character. It is called a porphyrite, and contains phenocrysts of either hornblende, augite, hypersthene, biotite, quartz, and felspar, or several of these in a holocrystalline but compact matrix of quartz and orthoclase. The silica percentage, omitting one doubtful and exceptional type, varies from 69-55, but is generally about 63, and the proportion of potash to soda, 2·5-4, is fairly constant. The porphyritic crystals, chiefly intratelluric in origin, have increased in size after the intrusion of the rock, and it is thought that the phenocrysts of orthoclase, which occasionally occur, have been completely formed after intrusion. Gilbert's hypothesis, that the laccolitic structure is determined by conditions of density, is not accepted in its entirety, the author quoting with approval Dana's criticism that Gilbert's explanation "appears to be complete without reference to this difference of density. With so powerful a forced movement as the facts, if they are rightly interpreted, show to have existed, no other cause could be needed for a flow to the surface in the case of an open channel, or for a flow to any level in the strata at which a fissure might terminate; and this is true, whether the lava be light or heavy." Hints are given throughout the paper that orographic movements may often have had a determining effect in the localisation of laccolites, a result already reached by some observers in Britain.

An exceptionally interesting piece of experimental work is contained in Mr. B. Willis's "Mechanics of Appalachian Structure."[1] A long series of experiments was undertaken, and is here illustrated by twenty-one large plates, while a number of maps, sections, and photographs from the Appalachian ground are of use to compare with the experimental results. In addition to the usual types of folds defined by the opposed dips, we have a classification according to compression into open, closed, and carinate or isoclinal folds. In the Appalachians the following districts are recognised: the district of (1) open folding, (2) closed folding, (3) folding with faulting, (4) folding with schistosity. One of the great questions to which the observer is led is this: As the "conditions antecedent to deformation were the result of sedimentation, does the distribution of strata afford an answer to the questions raised?" To investigate this problem a mixture of beeswax with plaster of Paris and Venice turpentine of varying consistency was used, in thin, large sheets, resting on a plastic support, and covered by shot to act as a load. This was contorted by lateral pressure applied by means of a slow-motion screw. One of the first results to come out was that any slight dip in the layers of material was usually sufficient to initiate a fold. "In strata under load an anticline arises along the line of initial dip, when a thrust, sufficiently powerful to raise the load, is transmitted by a competent stratum. The resulting anticline supports the load as an arch, and, being adequate to that duty, it may be called a competent structure." From this it follows that the size of an anticline depends on the competency of the stratum and inversely on the load. Some evidence has been obtained in the field that the initial dips in the Appalachians have influenced the folding. An interesting by-product of the experiments is the fissuring of tissue-paper placed between the layers, along lines at right angles to the wrinkles. The work then goes on to consider the packing of folds and the formation of faults. The plates illustrate the successive steps of each experiment of which the details are thought worthy of publication.

Owing to the small scale of the maps and to the rapidity with which surveying is carried out, it is often necessary to generalise the geological as well as the topographical features expressed on the maps, when it is desired to bring out important tectonic characters. This is pointed out by Prof. Iddings, and atoned for by the conscientious completeness with which he has worked out the petrological affinities of the intrusive and eruptive rocks of Electric Peak and Sepulchre Mountain.[1] Separated now by a great fault, with a downthrow to the north-east, along which a valley has been excavated, one of these masses—Sepulchre Mountain—was once situated almost directly over the other. Sepulchre Mountain is made up of volcanic accumulations, andesitic and rhyolitic breccias and lava-flows, with dykes and other eruptive volcanic products; Electric Peak consists of intrusive sheets, dykes, and "stocks" of porphyrite and diorite corresponding in a general way in composition with the rocks first mentioned, but differing in their coarser texture and more plutonic aspect. The relative date of the members of the intrusive series can be made out and paralleled stage by stage with the volcanic products, so as to make it clear that we have here side by side the surface and the deep-seated products of one volcano. This is expressed in tabular form, as follows:—

Electric Peak.	Sepulchre Mountain.
(*a*) Intrusive sheets of porphyrite.	(*a*) Andesitic breccias.
(*b*) Intrusion of dyke and stock rocks in the following order:—	(*b*) Andesitic breccias and dykes in the following order:—
Pyroxene-porphyrite to pyroxene- and hornblende-diorites.	Pyroxene-andesites to pyroxene-hornblende-andesites.
Hornblende-biotite-diorites and porphyrites.	Hornblende-biotites-andesites.
Quartz-biotite-diorite-porphyrite.	Dacites.

Such a parallelism cannot be the result of an accident, and it affords a most useful opportunity for the study of the relations of deep-seated and surface products; of this

[1] Thirteenth Annual Report of the Geological Survey of the United States, 1891-92. (1893.)

[1] Twelfth Annual Report of the Geological Survey of the United States, 1890-91. (1892.)

chance Prof. Iddings has not been slow to take the fullest advantage. The author does not use the word porphyrite in the sense of an altered or ancient andesite, but applies it to "medium-grained porphyritic rocks that occupy an intermediate position between the coarsely granular diorites and gabbros and the microlitic or glassy andesites." In describing the diorites, he gives a plate of examples of the intergrowth of such minerals as hornblende, biotite, augite, and hypersthene. The whole of the plutonic rocks are compared together as to structure and chemical composition, and shown to form a connected and overlapping series. Similar comparisons are effected between the volcanic products of Sepulchre Mountain. Mr. Iddings points out that it is impossible to trace any actual transition through stock and dyke rocks into the corresponding eruptive rocks, for the reason that they are often cut asunder while the volcano is in activity, and because the pipe is invaded by each magma in turn, the last alone remaining there to solidify, unless little patches of necessarily altered previous types happen by accident to survive.

In the nineteenth monograph, Messrs. Irving and Van Hise treat of the Penokee iron-bearing series of Michigan and Wisconsin. This is a monoclinal series of rocks dipping northwards off a mass of crystalline rocks which lie to the south, and extending a distance of eighty miles along their strike. The "Southern Complex" is a mass of schists of eruptive origin, with masses of granite intruding into them. Resting unconformably on this complex, comes a thin series of cherty limestones (300 feet) of aqueous origin, but whether chemical or organic is not known, and unconformably again on that, the quartz-slate (500 feet). The iron-bearing member (800 feet) in its least altered state is a water-deposited cherty iron carbonate, which can be seen to grade into ferruginous slates, these into ferruginous cherts with concretionary and brecciated structures, and these again into actinolitic slates containing much magnetite. This rock is penetrated by diabase dykes which, when intruded, appear to have been vertical, while the beds were horizontal. It results from this that, now both are tilted, V-shaped areas occur defined by the upper quartzite of the quartz-slate on the one hand, and the dykes on the other. It is in the apices of these V's, that the iron ore is now concentrated, the original rock being rendered very poor in ferruginous constituents, which have been re-deposited in the ore masses as hæmatite. In the area east of Gogebic Lake, the regular succession is disturbed by volcanic accumulations and greenstone conglomerates. The Upper Slate member (12,000 feet) rests on the iron-bearing rocks, but it does not extend quite so far as they do. The southern complex is placed in the Archæan system, the overlying beds into the Algonkian; these are covered by the Keweenawan series, after which the rocks received their monoclinal tilting; finally, the Eastern Sandstone was unconformably deposited on them all. The work is illustrated by a large series of illustrations of the microscopic structure of igneous and sedimentary rocks, and by maps and sections.

Mr. Walcott[1] gives an admirably illustrated account of the igneous rocks of the Unkar terrane, a group which underlies the Tonto Sandstone in the district of the Grand Cañon of the Colorado, and has been variously referred to the Algonkian, the Cambrian, and the Silurian by himself and other authors. The presence of a well-marked Middle Cambrian fauna in the upper part, and a strong unconformity at the base of the Tonto Sandstone, are sufficient in the opinion of the author to warrant our considering the Unkar beds as Pre-Cambrian, and correlating them with part of the Algonkian succession. The upper part of the Chuar terrane, which immediately underlies the Cambrian rocks, consists of 1700 feet of shales and sandstone, with 138 feet of limestone; the lower division of this terrane has 3420 feet of similar rocks, with 147 feet of limestone of a rather different type. Two of the limestones are spoken of as *Stromatopora* limestones, and they contain an organism which is probably a species of Cryptozoon.

The Unkar terrane which underlies that last described, is 6830 feet thick; there are magnesian limestones at the top, followed by lava beds 800 to 1000 feet thick, then sandstones and another lava bed from 80 to 180 feet thick on a limestone and conglomerate, which rest unconformably on the Vishnu schist, and the gneisses and schists of the Archæan System. The igneous rocks were probably submarine flows poured out from fissure eruptions, the dykes of which are still visible in the walls of the cañon, during a slow subsidence when beds of sandstone and shale were interleaved with the volcanic products.

Mr. Iddings, who contributes an appendix, describes the lavas as olivine-basalts sometimes fresh but more usually altered, the felspar passing into saussurite, the pyroxene to chlorite, and the olivine to serpentine and other products. When the original structure is well preserved, it does not differ much from that of the Tertiary lavas of the same area. The ground-mass of the basalts is usually microcrystalline, but in the middle of thick sheets it becomes ophitic, while the upper and under parts are scoriaceous and amygdaloidal.

In that lucid style for which his work is well known, Mr. Walcott[1] sketches out the physical history of the North American continent during Cambrian time. He shows that Dana's idea of the existence of a V-shaped skeleton, about which Palæozoic sediments accreted, is in the main correct, but he is able to fill in a number of details which were of necessity left blank by that author. The underlying massif is composed of Algonkian rocks resting unconformably on those of Archæan age; its rocks were tilted and uplifted into a land area, which Walcott proposes to call the Algonkian continent, and which was of wider extent than any land in this position until Mesozoic time. This continent consisted of four chief parts: (1) the V-shaped mass running parallel to the outlines of Hudson Bay, and possibly extending in a shield-like area to Texas and the Colorado River; (2) a Palæo-Appalachian range, with sub-parallel chains and spurs; (3) a Palæo-Rocky Mountain mass; and (4) a Palæo-Sierra Nevada mass. Sedimentation took place in all the seas defined by these land areas in early Cambrian (*Olenellus*) times; that is to say, in (1) the Atlantic Coast Province east of the Palæo-Appalachians; (2) the narrow sea extending from Labrador to Alabama; and (3) on the west side of the great V-shaped mass.

In Middle Cambrian times there was little change in the areas of deposition, except that partial barriers erected along the line of the Appalachians only allowed a small part of the typical (*Paradoxides*) fauna to penetrate westwards from the Atlantic basin. Strongly defined zoological provinces evidently existed in Middle Cambrian time, as proved by the study of the fauna of this period to the west.

Steadfast depression then began, and the Upper Cambrian Sea carried its sediments over the whole of the great south central region, including almost the whole of the United States as far north as Chicago, and from the Sierra Nevada to the Appalachians. The Appalachian barrier was, however, strengthened so that the fauna of the Atlantic coast in Upper Cambrian times was related to that of Europe, and quite distinct from that of the Central States. This great depression brought on the limestone deposits of the Ordovician system. The memoir is illustrated by several important geological and palæo-geographical maps.

[1] Fourteenth Annual Report of the Geological Survey of the United States, 1892-93. (1894.)

[1] Twelfth Annual Report of the Geological Survey of the United States, 1890-91. (1891.)

Volume xxiii. (1894) of the Monographs of the Survey is devoted to the geology of the Green Mountains in Massachusetts, by Messrs. Pumpelly, Wolff, and Dale. This district of Palæozoic rocks is complicated by two circumstances; in the first place, the limestones of Greylock Mountain appear to pass shoreward into the sandy and shaly beds of Hoosac Mountain to the west, and in the second place, metamorphism has proceeded much further at the western end of the series. Resting on the Stamford gneiss of Pre-Cambrian age comes the coarse gneiss of the east side of Hoosac Mountain, which is traceable into coarse conglomerate, "white gneiss," and quartzite as we pass towards the north and west. The lower part of the Hoosac schist passes similarly through the calcareous schist of the Hoosac Tunnel into the Stockbridge limestone. The upper part of this schist is perhaps to be correlated with the Berkshire and Greylock schist series, which are separated by the Bellowspipe limestone. The rocks are over-folded and faulted as well as metamorphosed, but patient mapping has unravelled the complex structure, and enabled the writers to assign the Stamford gneiss to the Pre-Cambrian System, the Vermont Formation and the Lower Stockbridge limestone to the Cambrian, and other rocks mentioned to the Silurian System. Much credit is due to the authors, and their assistants in the field, for such a careful and detailed piece of work, in which everything has been subordinated to the elucidation and presentation of the facts.

Mr. T. Nelson Dale,[1] in his account of the Renselaer Grit Plateau of New York, thinks that the grit occupies a place (probably unconformably) above the Hudson River shales, which are themselves equivalent to the Berkshire schists, but in a less altered condition, and in their turn rest on the Stockbridge limestone. The upper part of this last rock, which is crystalline and contains clastic grains of quartz and felspar, yields fossils of Trenton, Chazy, and Calciferous age, but its lower part represents much more ancient time, as it contains Cambrian fossils. and is thought to be the equivalent of the *Olenellus* limestone, which, further east, rests on Archæan rocks.

The grit itself is a coarse graywacké containing some secondary minerals, and interbedded with red slates and phyllites. On the west side of the syncline it is underlain by shales and phyllites of the Hudson River group, which pass towards the east into muscovite and chlorite schists which contain ottrelite, tourmaline, and more rarely albite. A map, coloured sections, some admirable photographs, and figures of rock-structure, illustrate the paper, which appears to be an excellent piece of minute stratigraphical and petrological work.

To the same author we owe an account of the structure of the ridge between the Taconic and Green Mountains in Vermont.[2] This consists of an anticline of lower Cambrian rocks overlain by Stockbridge limestone and Berkshire schist. The anticline is broken by a "keystone" fault, a thrust-plane, and one or two minor disturbances. Mr. Dale also gives another interpretation to the structure of Monument Mountain[3] differing from those advanced by Dana. He regards it as a synclinorium somewhat disturbed by faulting. The rocks involved are the Stockbridge limestone, the Berkshire schist, quartzite, and Silurian rocks.

Mr. A. Keith[4] gives an account of the Catoctin Belt, a region which is roughly the mountain tract of Maryland and Virginia, a geological continuation to the north-east of the Appalachian flexure system. The lowest rocks are relegated to the Algonkian System, and consist of a flow of diabase lava, followed by others of quartz-porphyry and andesite, and by intrusions of granite; these, again, are succeeded by other diabase flows: the diabases are now converted into the Catoctin schists. The overlying Cambrian rocks are divided into four, and the Silurian into three, divisions. A map of the whole area is given, and, in describing both igneous and sedimentary rocks, smaller scale maps are used to show variations in composition and structure. Lines are drawn on these maps through those points where a given band of rock has the same thickness (isometric or isodiametric lines, as they have been called), and by this means a very good idea of variation in thickness is given. Fossils found in the Cambrian rocks have been of the utmost use, not only in indicating the general age of the rocks, but also in making out the general succession, and in unravelling difficult bits of stratigraphy. The upper part of the Shenandoah limestone contains Silurian (? Ordovician) fossils, but its lower part yields lower Cambrian with some middle Cambrian forms. Above the representative of the Hudson River shales comes the Newark formation, of Jura-Trias age, which contains dykes and sills of diabase. The region underwent folding, thrusting, and metamorphism of Appalachian type before the Newark time, and subsequently was tilted and faulted on the monoclinal plan. It was planed down in Cretaceous times, and reduced to a base-level before the Lafayette period; certain portions which survived this second planing are delineated in a map. An interesting comparison is appended in which the amount of area planed down, and the amount of rock removed by different phases of denudation are used to obtain a rough estimate of the time elapsing during different parts of the Tertiary Period. This gives the following relative figures:—Tertiary, 134; Early Pleistocene, 1; Late Pleistocene, $\frac{3}{8}$; Recent, a small fraction.

Mr. C. S. Prosser's *Bulletin* on the Devonian Rocks of East Pennsylvania and New York[1] is an admirable piece of detailed stratigraphy, in which the fossils have evidently been carefully collected and identified from each important horizon, so as to place on record a number of facts that enable detailed comparison to be made with the better-known sections of western and central New York. About 8000 feet of rock are shown, of which 500 belong to the lower, 2200 to the middle, and 5300 to the upper division of the system. The bulk of the fossils are of marine type, but some land plants were discovered.

In his paper on a Geological Reconnoissance in North-west Wyoming, Mr. G. H. Eldridge[2] gives a description of the great anticline of the Big Horn Mountains and the three basins lying east, west, and south of it respectively. The rocks belong to the Archæan, Cambrian, Silurian, Carboniferous, Triassic Cretaceous, and Eocene systems. The Palæozoic rocks appear to be conformable throughout, and there seems to be no break between them and those of Mesozoic age until the summit of the Laramie beds is reached; several breaks occur in the higher beds. Coal, a lignite of good quality, is found in the Laramie terrane, oil in the anticlines of Trias and Niobrara beds, building-stone everywhere, and gold in the north part of the Big Horn Mountains. The hot springs and agricultural qualities of the soils are described, and useful analyses of forty coals are appended.

An account of the economic geology of a portion of the main Appalachian coal-basin, and of an outlier called the Potomac field, is given by Mr. J. D. Weeks in the fourteenth annual report.[3] The chief coals are the Pittsburg seam of the Upper Productive Measures, the Upper Freeport and Lower Kitanning seams of the Lower Measures, and the New River and Flat Top seam of the Pottsville conglomerate. A description of the measures and their coals is given, but some of the vertical sections

1 Thirteenth Annual Report of the Geological Survey of the United States, 1891-92. (1893.)
2 Fourteenth Annual Report of the Geological Survey of the United States, 1892-93. (1894.)
3 *Ibid.*
4 *Ibid.*

1 *Bulletin* of the United States Geological Survey. No. 120. (1894.)
2 *Ibid.*, No. 119. (1894.)
3 Fourteenth Annual Report of the Geological Survey of the United States, 1892-93. (1894.)

are at first rather misleading, as one scale is employed for the measures; another and much larger one for the interbedded coal-seams. It is pointed out that in many cases it is not the only, nor indeed always the best, seam which is actually mined at any particular spot.

Passing to the west side of the continent, we have first to deal with the work of Mr. H. W. Turner on the rocks of the Sierra Nevada.[1] The older set of rocks, which contain auriferous veins, and are spoken of as the auriferous series, are much disturbed, and it is very difficult to make out their exact relations, particularly as they are bent into a series of isoclinal folds. Fortunately, however, many of the beds contain fossils, by the aid of which it may be possible eventually to unravel their structure. The following Systems appear to be represented: the Silurian, Carboniferous (three divisions), Jura-Trias (?), Trias (two divisions), and Upper Jurassic or Lower Cretaceous. The last, or Mariposa formation, appears to overlap the others, and sometimes to rest on Carboniferous beds; but the maps which express this fact are not easy to interpret. These older rocks contain beds of lava and ash at many horizons, with intrusive rocks of all types, from granulite and granodiorite (or quartz-mica-diorite) to peridotites and pyroxenites. The sediments are often highly metamorphosed, and, so far as we may judge by the nature of the minerals produced, such as andalusite and sillimanite, in all probability by thermal action.

The newer rocks include representatives of the Upper Cretaceous, Eocene, Miocene, Neocene, Pliocene, and Pleistocene Systems. The Neocene rocks are the auriferous river gravels, and the Pliocene beds are shore gravels, which sometimes contain gold. These are associated with flows of rhyolite, basalt, and andesite of various types, and with great sheets of breccia and tuff derived from them. The Sierra appears to have received its chief uplift after the deposit of the Mariposa slates, and then to have been planed down in both Cretaceous and Tertiary times to an almost flat surface, which is in places preserved under the Tertiary volcanic accumulations. Late in Tertiary time came another great uplift, accompanied by faulting.

A very useful piece of economic work is that by Mr. W. Lindgren on the gold-silver veins of Ophir, California.[2] The country-rock consists of an area of schistose amphibolites towards the north-east, into which a mass of granodiorite was intruded at some date subsequent to the formation of the Mariposa slates. The amphibolites contain lath-shaped felspars set in hornblende, chlorite, and felspar, and they have evidently been derived from the alteration of diabases; the grandiorite consists of quartz, potash and soda-lime felspar, biotite, and hornblende. Dykes of amphibolite and the auriferous veins traverse both rocks, and the latter group themselves into four systems: a north-west and south-east set parallel to the strike of the schists, another set running north and south, a third west 10° north, and a fourth east 20° north. To some extent all the quartz veins bear precious metal, but the ore is concentrated into pockets and chimneys. While the veins in the granodiorite are more extensive, of low grade and rich in silver, those in the amphibolite are of smaller extent in depth and width, but richer in gold, poorer in silver, and frequently reduced to mere pockets. The amphibolite is in places impregnated with pyrites, and it is well known that where the veins cross these "iron belts" they become especially rich in ore. The minerals include native gold, silver, and copper, electrum, horn-silver, and many sulphides. Both types of rock are much altered along the walls of the veins, the amphibolite passing into an aggregate of carbonates, white mica, and pyrites.

The geology of the Eureka district, Nevada, by Mr. A. Hague,[1] contains an appendix on the fossils by Mr. Walcott, and another on the igneous rocks by Prof. Iddings. The work begins with a general description of the physical geography and geology, from which we gather that the following is the succession of the chief rocks of the district. The Cambrian rocks are 7700 feet thick, and are divided into the Prospect Mountain quartzite, the Prospect Mountain limestone, which contains an *Olenellus* fauna, the Secret Cañon shale, the Hamburg limestone with a Potsdam fauna in its lower and upper parts, and the Hamburg shale. The Silurian rocks are 5000 feet in thickness, made up of the Pogonip limestone with a Potsdam fauna at the base, then Chazy forms, and in the higher portion some of Trenton facies; the Eureka quartzite; and the Lone Mountain limestone with Trenton and, possibly, some Niagara fossils. The Devonian system is 8000 feet thick, divided into the Nevada limestone and the White Pine shale. The Carboniferous Formation has four members, the Diamond Peak quartzite, the Lower Coal Measure limestone, the Weber conglomerate, and the Upper Coal Measure limestone. The chief feature about the Carboniferous rocks is the fact that there occurs a freshwater fauna at the base of the Lower Coal Measure limestone, and a mingling of Devonian, Lower Carboniferous, and Coal Measure species in a limestone overlying beds characterised by a pure Coal Measure fauna.

These sediments are penetrated by granites, granite-porphyries, and quartz-porphyry, and are overlain by immense quantities of Tertiary or later volcanic rocks. The great eruptions for the most part cover subsided regions; where a mountain block has been uplifted, they occur at its borders. The succession of eruptions seems to have been as follows: hornblende-andesite, hornblende-mica-andesite, dacite, rhyolite, pyroxene-andesite, basalt. It is suggested that the original magma split up into two—one felspathic, the other pyroxenic; the felspathic eruptions become steadily more acid until rhyolite is reached, the pyroxenic eruptions more basic from andesite to basalt. The ore deposits are mainly of lead and iron rich in gold and silver. Originally deposited as sulphides, they have been oxidised by air and surface water. They occur in cavities in all the Cambrian, Silurian, and Devonian rocks except the great shale masses. One analysis gave 27·5 ounces of silver and 1·5 of gold to the ton.

Mr. Walcott's appendix includes a long list of fossils from all the beds. Mr. Iddings calls the granite an amphibole-granitite containing quartz, orthoclase, plagioclase, hornblende, and mica; the granite-porphyry is the chilled-edge phase of the granite-magma, of which the quartz-porphyry is the final phase. In all the volcanic rocks "there is a marked similarity between the individual crystals of the same mineral species wherever they occur . . . which links the various kinds of rocks together and suggests the possibility of a common source." The work is admirably illustrated by figures and photographs.

Mr. J. S. Diller gives an impressive picture of Tertiary denudation in his "Tertiary Revolution in the Topography of the Pacific Coast."[2] After the beds of the Shasta-Chico (Cretaceous) series were laid down, the country was planed down to a base-level. At the present time this "pene-plain" has an average maximum slope of 2°, which rises to 5°, and then somewhat rapidly up to 17°, on the flanks of the Klamath Mountains, a name used to designate the group which occurs at the junction of the Cascade range with the Coast range and the Sierra Nevada. The plain stretches across the head waters of the Sacramento River to the Sierra Nevada, and probably comes out at the other side of it in the

[1] Fourteenth Annual Report of the Geological Survey of the United States, 1892-93. (1894.) [2] *Ibid.*

[1] Monographs of the Geological Survey of the United States, vol. xx. (1892.)

[2] Fourteenth Annual Report of the Geological Survey of the United States, 1892-93. (1894.)

interior of North-East California and the adjacent parts of Oregon, being covered in the interval by Tertiary volcanic products. The plain is cut on to the Chico series and older rocks, and there rest on it the Ione formation, probably equivalent to the auriferous gravels, the Tuscan tuff, and the Red Bluff Pleistocene beds. It is noteworthy that the plant remains in the oldest of these rocks are of low altitude and not mountain types. There was evidently much movement in post-Chico time, then came erosion during the Eocene, and finally new movement with some warping and deformation. As the Eocene base-level was perfected erosion became much slacker, and was chiefly effected by solution, so that there was left much insoluble and dense material, including quartz and gold, ready to be deposited in the auriferous gravel when the next movement supervened, making the slopes steeper and giving the streams fresh impetus.

Returning now to the east, we have a lengthy account, by Mr. W. J. McGee, of the Lafayette Formation.[1] This writer has shown a remarkable adaptability in suiting his style to his subject, as he expresses it in the following sentence: "The history of development of the eastern land is recorded in nature in characters so grand that but a small part of a single one may be seen at once, so that the direct reading is difficult." The Coastal Plain of the United States is based on Cretaceous rocks, which are covered by the following rocks in order, the first having an uncomformable base: the Lignitic beds, the Claiborne and Meridian deposits, the Vicksburg-Jackson or White Limestone, the Grand Gulf beds, the Lafayette formation, and the Columbia beds. From this succession the author makes out the chief oscillations and changes in physical geography undergone by the Atlantic slope and the Mississippi embayment. The age of the formation we are left to judge from the following enigmatical sentence. "If the Cenozoic be not made to include the Pleistocene, and if the age be then divided into equal portions called Eocene and Neocene, and if then the Neocene be divided into ten equal parts, the Lafayette period may be supposed to correspond with the eighth or, perhaps, with the seventh or the ninth of these parts." The work closes with an account of the material resources of the formation, soils, siliceous clays, gravel, and iron, followed by the history of events recorded in the rocks. Mr. McGee illustrates his paper with some excellent maps, and also contributes to the fourteenth Annual Report a geological map of the whole of the United States at present surveyed.

W. W. W.

THE GAME FIELDS OF THE EASTERN TRANSVAAL.[2]

IN proceeding into the interior of Africa from almost any point on the eastern coast, the traveller passes over a low coastal plain to the foot of the scarp of a high plateau. This plateau is succeeded to the west by a still higher one, which is gained either by a second steep ascent or by a gradual slope. The existing river valleys and former earth-movements have in places interrupted this arrangement; but, notwithstanding a few such exceptions, it persists with remarkable uniformity from Abyssinia to Natal, where the dominant meridional geographical lines bend round into the east and west series that rules in Cape Colony. In the eastern Transvaal, this zonal arrangement of the country is well developed. Inland from Delagoa Bay is a tract of undulating lowland, ending at the foot of the Libombo Mountains, which separate Swaziland and the Transvaal from Portuguese East Africa. Seventy miles further to the west is the parallel range of the Drakensberg or Kahlamba (to adopt the author's spelling of the name, which is usually written Quahlamba). Between these mountain ranges is a belt of bush-covered veldt. The Crocodile River (a tributary of the Komati) and the Olifants River flow from west to east across this belt, at a distance of about 100 miles from one another. These, with the mountains, enclose a roughly quadrangular area, some 7000 square miles in extent, which is the favourite hunting-ground of Mr. F. V. Kirby. Small though this area is, it includes very varied types of country. To the west are the densely wooded eastern slopes of the Drakensberg, and part of the turf-clad plateaus or terraces beyond; to the east lies low country with sub-tropical vegetation, intervening between the Libombo Mountains and the Limpopo River.

FIG. 1.—A Head of the Great Kudu.

Most of the area consists of barren, scrub-covered plains known in this part of Africa as Bush-veldt, and near the equator as the Nyika. Most of this area was once rich in game. In the Bush-veldt lived the rhinoceros and buffalo, the sable and roan antelopes, the gnu, waterbuck, zebra and mpalla. The wooded foothills of the Drakensberg, or the "Kloof Country," was the home of the koodoo, the hill-leopard, the bush-buck, and the reed-buck. On the western plateau, or the "Krantz Country," in addition to some of the animals mentioned, lived the oribi and the mountain reed-buck.

This book relates the experience of nearly twenty years of hunting in this rich game country. The author tells his story in much better English than we are used to in books of sporting adventure. He is obviously not only a skilled sportsman, but a man with a keen eye for fine scenery, of literary tastes, and a careful and patient

[1] Twelfth Annual Report of the Geological Survey of the United States, 1890-91. (1891.)

[2] "In Haunts of Wild Game. A Hunter-Naturalist's Wanderings from Kahlamba to Libombo." By Frederick Vaughan Kirby, F.Z.S. 8vo. Pp. xvi + 567. With map, portrait, 16 full-page and 24 smaller illustrations. (Edinburgh and London: Wm. Blackwood and Sons, 1896.)

observer. His book is somewhat lengthy, and consists in the main of descriptions of successful stalks, night-watches, and exciting encounters in the chase of the various classes of game. Every page will be of interest to sportsmen; while the notes on the habits of the game, and the descriptions of variations from the normal forms, render it of importance to naturalists.

The book is divided into two parts. The first describes shooting in the "Krantz" and the "Kloof" countries; the second, that of the Bush-veldt. As the district is settled, and the natives friendly, and as the railway to Pretoria passes along the southern border of the country, the conditions of life are very comfortable. The author shot with dogs, generally on horseback, and in the case of smaller game, had the help of large parties of beaters. But the sport was not always by any means of the battue type. Five chapters out of the thirteen in the first part of the book are devoted to leopard hunting, which is always arduous, and one to buffalo hunting, which is generally dangerous. The author has great respect for the leopard, and protests against its being described, as he says it generally is, as "a contemptible sneak" and "utter coward." He describes it, on the contrary, as "an incredibly daring brute," and says it "will usually show fight where a far larger and more powerful animal would try to back out of it." But we thought that this estimate of the courage of the leopard was generally accepted, although the author describes the other as that which is invariably held. The five chapters on lions and lion-hunting, in the second part, will probably be the most generally attractive in the work. The author scorns the idea that the lion is not the king of beasts, and his experiences certainly show that its courage is sometimes superb. His remark, however, that in the case of lions, "if not interfered with or actually in a starving state, there is absolutely nothing to fear from them if met in the day-time," is not supported by recent accounts from Equatorial Africa. Some lions there recently, in broad daylight, attacked and routed a hundred men belonging to a Uganda caravan. The last chapter in the book is a discussion of the respective merit of rifles, in which the author takes the side of heavy weapons. He declares the ·303 to be a very over-rated gun, and most of his arguments seem to me quite sound, at least as far as concerns the professional sportsman. The author, however, perhaps does not sufficiently consider the case of those with whom sport is only secondary to other work. He says that the advantages claimed for the ·303, owing to its lightness and absence of recoil, are fictitious; for sportsmen must be so strong, that the few extra pounds make no difference, and that they do not feel the recoil of a ·577. This is no doubt true, if potting game is a man's sole occupation; but if in addition to a rifle he has to carry a butterfly-net and a satchel of collecting-bottles, every pound saved is of great importance. It is no doubt true, that during the excitement of the chase, a sportsman does not feel any inconvenience from half-a-dozen blows from a ·577; but if, during the next few hours, the traveller tries to take an altitude, or read a round of angles with a theodolite, he will find that he *has* felt the recoil, and has to pay for his sport by less accurate observations than he might otherwise have taken.

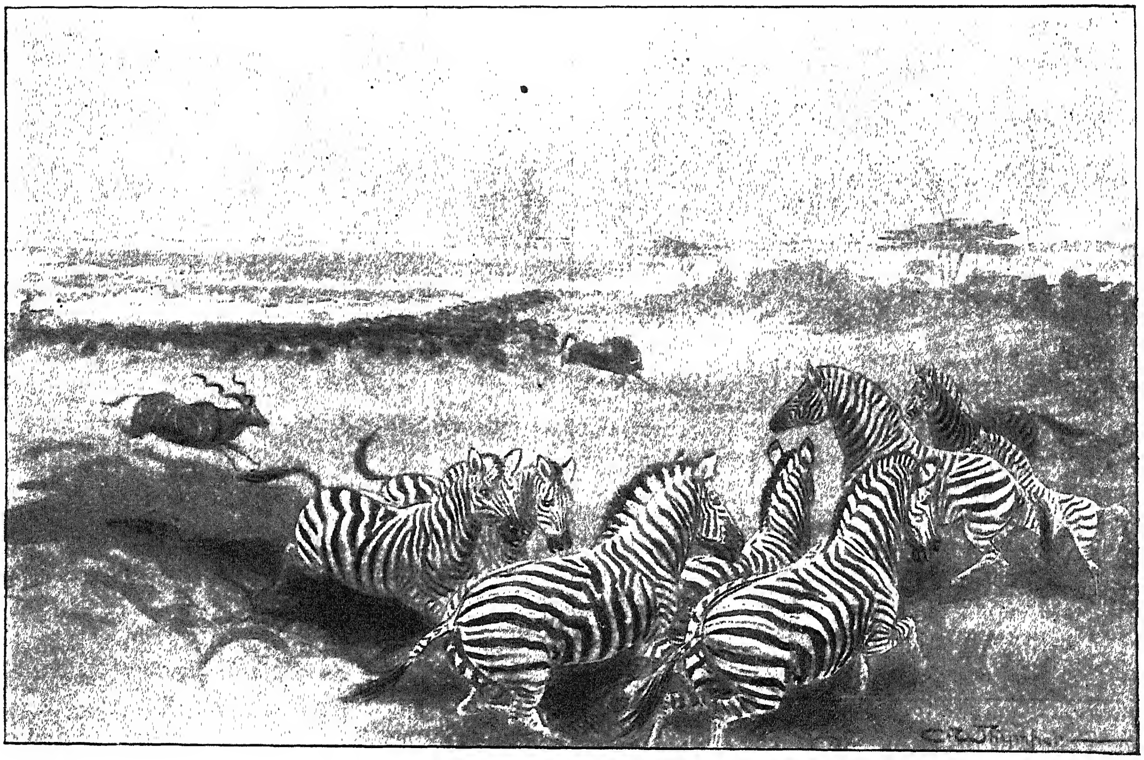


FIG. 2.—A Scene on the Game Fields.

The interest of the book is greatly enhanced by Mr. Charles Whymper's illustrations, which are a valuable addition to that artist's series of studies of wild animal life. By the courtesy of the publishers two are here reproduced as examples. In the picture of the game-fields, the artist has well illustrated the inquisitive zebras' stupid habit of swinging round occasionally to satisfy their curiosity as to danger, from which they might otherwise escape.

The most regrettable feature in the book is the author's habit of using native or local names for animals without giving the zoological name. Comparatively few of his readers are likely to recognise the *hyrax* or coney in the "dassie," especially as this term is not mentioned as a synonym in the notes on the fauna in the last chapter. The author's interesting remarks on some snakes lose much of their value, owing to the uncertainty of knowing which species he is describing.

The author's account of life on the game-fields shows that these are not Edens. His realistic account of a fight between a lion and a sable antelope, which resulted in the death of both combatants, and of a zebra which he shot, only to find that it had been so wounded by lions, that much of its flesh was putrid, and that it was full of maggots, help one to realise the tragedy of the struggle for existence. The author blames the Boer Government for allowing the destruction of the game; but the case of South America shows how a fauna, much richer than that of Africa, has become extinct in comparatively recent times, and without human intervention. The extermination of some species in regions of Africa where the game has not been seriously hunted, shows that natural agencies help in that destruction of the game, for which man generally bears the whole of the blame.

J. W. G.

GENERAL J. T. WALKER, R.E., C.B., F.R.S.

By the death of General James T. Walker, on February 16, the Indian Army, all scientific bodies, and geographical societies, at home and abroad, have to deplore the loss of a gallant and accomplished officer. It is a loss which will be felt most by past and present members of the Indian Survey Department who survive him, who are better cognisant of and can appreciate the many years of service he rendered that Department from first to last, and the talents he devoted to its accurate execution.

Following in the footsteps of previous Superintendents of the Trigonometrical Survey, Colonel Lambton, Sir George Everest, and Sir Andrew Waugh, his principal aim, in guiding the trigonometrical work they had performed, was to carry it to a successful issue, and with the greatest accuracy, more modern instruments, and all that mathematical and geodetical knowledge could achieve. These operations could not have fallen into more zealous, able hands, for it may be said, for the information of those who hear and read little of such work (often insufficiently rewarded), that as a survey of a very large area of the earth's surface, no other area has been so laboriously measured, the observed angles so rigorously computed, and dealt with, and with so little resultant error. Many accomplished brave officers, assistants, and men have also fallen victims to the climate in which the operations were carried on, ranging as it did from the plains of India to the often deadly Terai up to the highest peaks of the Himalayas. In achieving this result, to General Walker, and the officers he directed, is due the greatest measure of praise for its perfectness. All that it entailed from the very commencement in 1800, is to be found in the "Account of the Operations of the Great Trigonometrical Survey of India," twenty volumes, the first nine of which were compiled by General Walker. My first knowledge of his name and work was as far back as 1855, when serving with my regiment at Peshawur I drew for the Quarter-Master General's Department, under the direction of Dr. P. Lumsden, the first map of the Kooram Valley, on which were laid down the peaks on the Sufaidkoh Range, of which Walker had been the first to fix the position. Lieut. Walker's name was well known then in the Panjab, for up to 1853 he had been working single-handed with his usual zeal at the military survey of the Trans-Indus territory. This was dangerous service in those days on that disturbed wild frontier of the north-west of India, which the East India Company had very lately acquired, where the tribesmen might be seen following their bullocks at the plough, *jezail* slung on back. On this survey it may be said Walker carried his life in his hand, he and his party often being the target for these same *jezails*. The ascent of Turturrah Peak in the Khyber Hills is only one instance of a very hazardous piece of work, but the dash and rapidity with which his plans were made and the distance done, surmounted the difficulties, and brought him safe out of the expedition with the coveted angles secured. Similar risky exploration was effected by him on the borders of Eusofzai and along the base of the hills, near where our troops have been lately employed at the Malakand Pass, and in the neighbourhood of Umbeyla. In fact, all we knew of that border topography for many years, and up to very recently, was the outcome of the young engineer's reconnaissance. Very little was said about this work at the time. In those days it was not the fashion to write up, and make so much of such travel, as is now the case. It took place far off in time and distance from home and headquarters, and only those in the district—his immediate superiors and his brother officers—knew the value of it, and the pluck and endurance it demanded. Moreover, by his tact with some of the chiefs, he managed to penetrate even beyond the frontier; but on returning to Peshawur, and reporting his success in this way, and making certain of praise, he received a severe reprimand. It was perhaps feared that in risking his own life, and the men of his party, he also risked embroiling his Government. It was not until 1865, when I had been in the Survey Department some years, and knew more of his work, that I became personally associated with him and under his immediate orders. He was then engaged on the compilation of his first map of Central Asia. I shall never forget the great pleasure of meeting him daily, and how much I learned from him, discussing portions of that country, looking up books of travel, and the latest work of the Russian Survey, and getting that map completed with the Himalayan Range as far east as longitude 81°. It was the first large map turned out in India by the process of photozincography, then but lately introduced into the office at Deyrah Dhoon, and it went through many subsequent editions. It was when engaged on such researches that Walker's knowledge and his intense love for geographical study showed itself. There was at that period much new topography coming in. The work of the Kashmir Survey, under Captain T. G. Montgomerie, R.E., had filled up an immense blank in the northern frontier of India, from the confines of Gilgit and Hunza Nagar to the Chang Chingmo. Mr. W. H. Johnson had just returned from his trip over the Karakoram range to Ilchi in Khotan; his route survey and observations had to be brought into place, and affected the position of other places in that part of Asia.

It was never my good fortune to serve under General Walker in the field; but I can look back on a short spell of camp life with him, on the mountains north of Mussoorie, with those feelings of desire that the time might come over again. Walker had been working hard for months at his computations, and was overworked; I suggested his joining me in a collecting trip I had planned into the hills, and he fell in with the idea. How he enjoyed the complete rest, and entered with zest into my pursuits; how much there was to talk over that was interesting to both; how we revelled in the lovely scenery of the oak-crowned ranges, with the snows of Jumnutri in the distance, and enjoyed the splendid air of October in the Himalayas, which sent him back to duty again quite set-up. In those few days, however, I got to know Walker, and all the good traits in his character, better than per-

haps in a far longer interval of departmental work. Only as one of his many assistants do I now put on paper my own feelings on the loss we have all sustained. A full record of his service and life can only be written by some officer of the Survey who was closely and long associated with him in his geodetical labours.

General Walker passed out of Addiscombe into the Bombay Engineers in 1844, and landed in India in 1846; he retired in 1883. He was an officer of high training and ability, who worked zealously in his profession, and expected others to do the same, taking a keen interest in their work. He had a good record of hard military service during the Panjab campaign at the Siege of Multan and Battle of Gujerat, and during the Mutiny at the Siege of Delhi, where he was severely wounded; he also served in 1860 with the Mahsood Waziri Expedition. He was as good a field surveyor as a geodecist, with a reputation outside his own corps and country; for twenty-two years in charge of the Trigonometrical Survey, and five years Surveyor-General of India; and he was a constant writer on many subjects relating to geography, almost up to the time of his death. Fuller details of these services are to be found in an excellent obituary notice by Mr. Clements Markham, President of the Geographical Society, in the March number of the *Geographical Journal*. H. H. G.-A.

NOTES.

Lord Kelvin has communicated to us the following telegram which he has received from Edison: "Just found calcium tungstate properly crystallised gives splendid fluorescence with Röntgen rays far exceeding platino-cyanide rendering photographs unnecessary."

The Committee of the Athenæum Club, acting under the provisions of the rule of the Club which empowers the annual election by the Committee of nine persons "of distinguished eminence in science, literature, the arts, or for public service," have admitted to membership Prof. Arthur Schuster, F.R.S.

We regret to announce the death at Madras, on February 14, of Mr. Marmaduke Alexander Lawson, M.A., F.L.S., Government Botanist and Director of Cinchona Plantations to the Madras Government. Mr. Lawson held for many years the posts of Sherardian and Sibthorpian Professor at Oxford, which were separated on his resigning to take up a new position in India in 1882.

The French Government has decided to continue to M. Pasteur's widow the annual pension of 25,000 francs (£1000) granted to her regretted husband in 1883.

Prof. Arthur Auwers and Prof. Karl Weierstrass, both of Berlin, have been elected foreign members of the Royal Academy of Mathematical and Physical Sciences of Naples, in the place of the late Profs. Cayley and Hermann von Helmholtz.

The Royal Academy of Mathematical and Physical Sciences of Naples offers a prize of 1000 lire for the best essay (illustrated by specimens) on the geology of the quaternary lakes of the Basilicate. The essays have to be sent in on or before June 30, 1897.

Mr. W. L. Sclater has left England to take up his appaintment as Curator of the South African Museum, Capetown. His successor in the science-mastership at Eton College is Mr. M. D. Hill, of the University of Oxford.

Mr. Edwin Wheeler, of Clifton, Bristol, has presented to the Natural History Museum a valuable series of water-colour drawings of fungi—2449 in number—made by him in illustration of the British fungus flora. The drawings, which fill twelve bulky volumes, represent the result of assiduous labour and observation extending over many years, and the Museum authorities are fortunate in receiving so munificent a gift.

The "Coral-Reef Expedition," under the command of Prof. Sollas, F.R.S., will shortly leave England for the Pacific. Mr. J. S. Gardiner, of Cambridge, who has been selected as Assistant Naturalist, will devote himself to an examination of the fauna and flora of the Ellice Islands, while a deep hole is being bored into the coral-beds of Funa-fute, with the object of ascertaining the depth and exact structure of the formations.

Excellent accounts continue to be received of the progress made by Dr. Forsyth-Major in Madagascar, and several valuable collections made by him have already arrived at the British Museum. Amongst these are numerous remains of the extinct gigantic birds of the family *Æpyornithidæ*, the study of which will, it is expected, considerably increase our knowledge of the structure of this group. The specimens are being examined by the officers of the Geological Department.

Amongst the natural history collections from British Central Africa, last received from Sir Henry Johnston, is a small series of birds obtained, by Mr. Alexander Whyte, on the previously unexplored mountain of Chiradzulu, half-way between Blantyre and Zomba. With the specimens is an example of a new and very beautiful species of Oriole, which Captain Shelley will describe and figure in the next number of the *Ibis*, as *Oriolus chlorocephalus*.

Mr. J. E. S. Moore, who is gone on a mission from the Royal Society to explore the fresh-water fauna of Lake Tanganyika, arrived at Zomba, British Central Africa, on his way there in December last. He was obliged to stop there on account of the Stevenson Road being blocked by the Arabs; but the road having been since cleared by the Commissioner's forces, will now be open for Mr. Moore's further progress to Lake Tanganyika, where we have no doubt he will reap an abundant harvest.

The Zoological Society have lost the large male Indian elephant which was brought home by the Prince of Wales on his return from India in 1876, and presented by his Royal Highness to the collection. After carrying an innumerable number of children up and down the walks for the past twenty years, "Jung Pasha" died quite suddenly on the 8th inst. Although tuskless, he was pronounced by all those experienced in such matters to be one of the finest and largest of living Indian elephants. His skin has been presented to the British Museum of Natural History, and is being stuffed for exhibition in the Mammal Gallery.

As a direct outcome of Mr. Saville-Kent's book on "The Great Barrier Reef of Australia," Prof. Alexander Agassiz has, as already briefly announced, determined to undertake an expedition, having as its express object the investigation of the many subjects associated with this vast and specially interesting biological area. Soundings, and an examination of the ocean bottom and the study of the pelagic and surface faunæ, are subjects which will especially occupy Prof. Agassiz's personal attention. In order to utilise the opportunities that will be presented to their fullest extent, Prof. Agassiz takes with him a trained staff of artists and assistants, and has also engaged the services of the experienced American collector, Mr. W. Ward, to make typical collections of the Madreporarian corals characteristic of the Great Barrier region; and with the special purpose of securing extra large specimens, for exhibition at the Cambridge, Mass., and other of the United States museums.

Prof. Agassiz has been in communication with Mr. Saville-Kent for some months past with reference to the best season of the year and most favourable localities to adopt as the bases of operation for both himself and collectors, who will work independently. Mr. Saville-Kent has asked Mr. Ward to make a measurement of the selected coral growths at Thursday Island, of which he took photographs and constructed a diagrammatic chart six years since. He has also commissioned Mr. Ward to secure certain of the more appropriate of these types, with their registered accession of growth, as a supplementary addition to the extensive series of the Great Barrier reef and other Australian Madreporaria that he has already contributed to the Natural History Museum.

OUR American correspondent writes, under date March 6:—Mr. Daniel G. Elliot is on his way to Africa, where he will hunt large game for the Field Columbian Museum of Chicago. He will have charge of 150 men. At a meeting of the Board of Managers of the New York Botanical Garden, held on March 4, it was announced that the following persons had become patrons: J. Pierpont Morgan, Andrew Carnegie, Cornelius Vanderbilt, J. D. Rockefeller, Darius O. Mills, Addison Brown, James A. Scrymser, William C. Schermerhorn, Charles P. Daly, Oswald Ottendorfer, Samuel Sloan, George J. Gould, Miss Helen M. Gould, J. S. Kennedy, William Rockefeller, James S. Constable, Mrs. Esther Herrman (who contributed 10,000 dols., instead of 5000 dols., which was her first intention, as announced in NATURE of February 6), and James R. Pigeon. The Committee on plans and buildings submitted plans for the greenhouse. An acre is to be covered by glass, and a tower sixty feet high is to be erected in the middle. The Committee was authorised to obtain final plans from architects for the large museum which is to be erected. The scientific directors were authorised to purchase for the garden museum the herbarium of Mr. J. B. Ellis, of Newfield, N.J., consisting of 75,000 specimens of fungi.—The storm of March 2–5 was unparalleled at New York City for the protracted severity of the winds, which at one time reached the velocity of eighty-two miles an hour, being two miles faster than any previous record here. Great difficulty was experienced in navigation in the harbour on account of ice, and travel ashore was more interrupted by snow than at any time since the memorable blizzard of March 1888.

IN connection with the affiliation of Photographic Societies with the Royal Photographic Society, six experimentally-illustrated lectures will be delivered upon the subject of "Photography with the Bichromate Salts," beginning on Friday, April 10, and ending on Tuesday, April 28.

A MEETING of the Institution of Naval Architects will be opened in the hall of the Society of Arts, on Wednesday, March 25, and will be continued on the two following days. The Earl of Hopetoun, President of the Institution, will occupy the chair.

THE anniversary meeting of the British Ornithologists' Union has been fixed this year for Wednesday, April 22, when a large attendance is expected. The Union now numbers nearly three hundred members.

THE next Annual Meeting of the American Microscopical Society will be held at Pittsburg, Pennsylvania, from August 18 to 20. The President for the year is Dr. A. Clifford Mercer, of Syracuse, New York.

AMONG the lecturers and their subjects at the Royal Institution after Easter are:—Prof. James Sully, on child-study and education; Mr. C. Vernon Boys, on ripples in air and on water; Prof. T. G. Bonney, on the building and sculpture of Western Europe (the Tyndall Lectures); Prof. Dewar, on recent chemical progress; Mr. W. Gowland, on the art of working metals in Japan; Dr. Robert Munro, on lake dwellings; and Dr. E. A. Wallis Budge, on the moral and religious literature of Ancient Egypt. The Friday evening meetings will be resumed on April 17, when a discourse will be given by M. G. Lippmann, on colour photography; succeeding discourses will probably be given by Prof. G. V. Poore, Colonel H. Watkin, C.B., Prof. Silvanus P. Thompson, Prof. J. A. Ewing, and Prof. J. A. Fleming, among others.

WE regret to announce the discontinuance of the *American Meteorological Journal* after the forthcoming April number, which ends the twelfth volume. Mr. Robert Ward informs us that the journal has been carried on at a financial loss on the part of the editors ever since its foundation in 1864, and the present step has been decided upon because there seems no hope that it will become self-supporting. Arrangements have been made with the editor of *Science*, whereby Mr. Ward will contribute short notes on, and reviews of, current meteorological publications to that periodical. He therefore hopes authors will send their publications to him in the future as they have done in the past.

THE St. Louis Observatory, at St. Helier, Jersey, is being developed under the able direction of Père Dechevrens, formerly of Zi-ka-wei, in China, well known for his researches on wind, and other subjects in meteorology. This observatory is situated on a small open plateau above the Jesuit College, and one feature of it is a tower, of Eiffel type, about 170 feet high, with spiral staircase, and a number of instruments at the top, connected by a cable of twelve electric wires with recording apparatus in the house. Among these instruments is an anemometer of somewhat special design. A T-shaped support, with orienting arrangement, bears on one arm an anemometer with half cylinders instead of the usual cups, being thus made sensitive, it is claimed, to horizontal currents only; while a helical fan on the other arm gives the vertical component. The *Bulletin* for 1895 (the second year) contains very full information of the various weather elements, including hourly variation of pressure and temperature, and of the velocity of the wind. It is a curious fact, observed at this station, as at the Eiffel Tower in Paris, that the diurnal variation of wind velocity shows an opposite character near the ground and at the top of the tower; in the former case the velocity reaches its maximum about midday, and in the latter about midnight. The climate of the Channel Islands is interesting in many respects, and a well-equipped station like that of St. Louis may be expected to add largely to our knowledge of it.

THE Report of the Meteorological Council for the year ending March 31, 1895, has just been presented to Parliament. The Council have continued the practice of lending instruments to captains of merchant vessels for the purpose of obtaining observations made at sea, and of supplying instruments to the Royal Navy. A very large proportion of logs returned are classed as "excellent," and these observations have been largely supplemented by the Remark Books kept on H.M. ships, and by logs received from the Ocean Steamship Company of Liverpool and others. Among the works actually published, or in course of publication, are charts of the Red Sea, current charts for all oceans, and meteorological charts embracing the area from the Cape of Good Hope to New Zealand. It was for the purpose of collecting and publishing information of use to seamen that the Meteorological Department of the Board of Trade was first established in 1854, as the outcome of the Maritime Conference of Brussels in the previous year. But as time went on, the attention of Admiral FitzRoy was turned to the more practical branch of weather prediction, and this subject now forms an

entirely distinct and important department of the Office. Storm signals are supplied to all ports at which the local authorities will undertake their management. The report shows that the signals were hoisted at 180 stations, but more recently the number has been considerably augmented by their exhibition at exposed lighthouses, for the benefit of passing vessels. Weather forecasts are prepared three times daily, and are also sent to a selected number of agricultural districts during hay-making. A comparison of the results obtained for these forecasts gave a total percentage of 89, which is considered to be very satisfactory. The department dealing with climatology of the British Isles receives observations from 245 stations; the results are collated and published in various forms, available for present or future discussions. Much attention is also paid to the collection of rainfall values, the comparison of various kinds of anemometers, and other researches.

THE report of the Committee, appointed in May of last year, to inquire into the causes of the explosion, and the precautions required to ensure the safety, of cylinders of compressed gas, has now appeared. The Committee, in addition to examining manufacturers of the cylinders in which compressed gases and liquefied gases are sold, and some of the engineers who make and compress the gases, visited works where the manufacture is carried on, and conducted a series of experiments to determine the causes of the accidents to cylinders, and on the amount of damage such explosions are likely to produce. The information thus obtained has enabled them to draw up a detailed statement of the conditions which are necessary to secure safety in the transport and use of compressed gas cylinders, and as to the regulations which would be desirable to prevent risk. The risks of explosion fall into two classes, viz.: (1) risks due to negligence in the manufacture, annealing, and testing of the cylinders; (2) risks due to neglect of precautions in filling the cylinders. As the manufacture is carried on very extensively, and is likely to increase, the Committee think that the risks would be reduced if there were some control of the trade of making cylinders by official inspection. They suggest that there should be a general inspection of all factories manufacturing compressed or liquefied gases. If an inspector were satisfied that the arrangements at any factory were adequate, and that the precautions laid down in this report were being taken, a certificate would be granted authorising such factories to test and mark cylinders. It is suggested that a first thorough inspection, and an occasional inspection subsequently, at intervals of about six months, would be sufficient as a ground for granting and renewing certificates. The report is signed by Profs. W. C. Unwin, C. V. Boys, H. B. Dixon, Dr. A. Dupré, and the Rev. F. J. Smith.

HITHERTO most experiments with the Röntgen rays in this country have been made with the object of photographing living human hands and feet, in which only the bones are represented. On the continent, however, the "new photography" has been employed with remarkable success to delineate the arteries in a hand injected with a substance opaque to the Röntgen rays. Some experiments of this kind are described by Dr. Uberto Dutto, of Rome (*Att. R. Acc. Lincei*). Observing that the opacity of bones to the new rays is probably due to salts of calcium, of which they so largely consist, a human hand was injected with a paste of plaster of Paris sufficiently thin to penetrate the smaller arteries, and as soon as this had hardened, the hand was photographed in the usual way, the Crookes' tube being fixed at sufficient distance from the plate to produce sharp outlines. It would be interesting to try obtaining stereoscopic views of such specimens; this could, no doubt, be readily done by projecting the rays obliquely on the specimen and plate, first from one side and then from the other. Dr. Dutto points out the great value of this method in facilitating the study of anatomy.

IN one of a series of articles on the use of the Crompton Potentiometer, which he is communicating to *The Electrician*, Mr. Fisher gives some very interesting tests which have been applied to standard Clark cells. The form of cell used is that supplied by Messrs. Muirhead, in which the positive pole consists of a spiral of platinum wire amalgamated and filled with mercury. It is very generally believed that if by any chance a Clark cell becomes short-circuited, then the cell is either totally ruined or only recovers after a very long time. Mr. Fisher has shown that the Clark cell will stand very much rougher usage than one would think, and still recover even in a very short time. In one set of experiments a Muirhead pattern cell had for one minute a potential applied to the terminals of $\frac{1}{100}$ volt in excess of the electro-motive force of the cell. As a result, the electro-motive force rose about three parts in 14,000; but regained its normal value after ten minutes. After short-circuiting for one minute through 500 ohms the electro-motive force fell from 1·4323 volts to 1·431, but recovered its normal value after thirty minutes. Short-circuiting the cell through two inches of No. 18 copper wire for thirty seconds caused a drop from 1·4319 volts to below 1·431; but after thirty minutes it had almost recovered. A cell having been short-circuited through a few inches of copper wire (No. 20) for twenty hours, its electro-motive force fell to 0·17 volt. The recovery was at first very slow, and continued so till it reached 0·5 volt, the average rate of recovery being 0·03 volt per hour. After this the recovery was much more rapid, and in twenty-four hours the cell had almost completely recovered. The effect of applying a constant potential of 1·4 volts to a cell which had been "dead" short-circuited for twenty hours, was to very much hasten the recovery, so that after two and a half hours it had regained its former value. The author has found that the resistance of a Clark cell rises very rapidly if the cell is used to send any appreciable current, and he supposes that whatever is the cause of this increase of resistance and the fall of potential, it in is a great measure of the character of a "skin effect." Some tests made of two cells set up by Prof. Fleming in 1886 or 1887, seem to show that when these cells were in continuous use, so that they were employed to send small currents, and had small currents driven through them, their electro-motive forces were in very much better agreement than when standing idle. From these and other experiments the author concludes that the passage of these small currents through standard Clark cells is decidedly beneficial.

The South Slavs have a number of independent folk-songs which, unlike the great Homeric epics, have not been welded into an harmonious whole. Dr. Krauss (*Internationales Archiv für Ethnographie*, vol. ix.) elucidates these songs by notes on various customs and beliefs, especially those relating to death and burial. The South Slavs save money during the whole of life in order to ensure a grand funeral, and they honour graves and graveyards in many ways, considering it a crime to cultivate the ground of a graveyard; but the Catholic priests of Pozega did not hesitate to do so, and grew in them the best cabbages and the largest turnips in the district. There is an amusing account of cuckoo folk-lore in the same journal; and though the legends vary slightly, the cuckoo is regarded by all the South Slavs as a woman changed into a bird for excessive mourning over a dead son or brother.

WE have received from Miss E. A. Ormerod the nineteenth of her valuable "Reports on Injurious Insects," dealing with insect pests which were specially noticeable during 1895. It is fully equal, both in size and importance, to its predecessors, and is

divided into three sections, the first being devoted to insects, &c., injurious to cultivated plants; the second to flies injurious to horses, cattle, &c.; and the third to ticks. In her preface, Miss Ormerod alludes to the fact of the terribly cold weather experienced during January and February, 1895, having had no apparent injurious effect whatever on insect life. She also alludes to the great loss which entomologists have lately suffered by the death of Prof. C. V. Riley. As usual, the report is fully illustrated; but a new and striking feature is the insertion of two full-page illustrations of the foot of the Forest Fly (highly magnified, of course) the thick curved claws of which, as thus represented, present a curious and by no means remote resemblance to a pair of cow's horns. The first insect mentioned in the report is the Eyed Hawk-moth, the larva of which seems to be very injurious to apple-trees at times, though often overlooked from its colour resembling that of the leaves of the tree. As a rule, however, the larger *Sphingidæ* are rarely common enough in England to be destructive; but it is self-evident that no insects which feed on cultivated plants can be harmless, when unusually abundant. We hope to have the pleasure of receiving Miss Ormerod's annual reports for many years to come. The practical usefulness of entomology was formerly held in doubt; but such reports alone ought to be amply sufficient to remove the last remains of uncertainty on the subject.

IN a paper in the *Transactions* of the English Arboricultural Society for 1895, "On the Effect of Frost on Trees and Shrubs," by Dr. William Somerville, the growth of the Black Austrian Pine is recommended in exposed situations subject to severe cold, that tree having escaped almost entirely unscathed from the effects of the intense frost of the winter of 1894–95.

WE have received the report of the proceedings of the Annual Meeting of the American Microscopical Society, held last year at Cornell University, Ithaca, New York, contained in the *Transactions* of the Society. The address of the President, Mr. S. H. Gage, was on the "Processes of Life revealed by the Microscope: a Plea for Physiological Histology." The volume includes also reports of a number of papers in various departments of microscopy and natural history.

THE *Kew Bulletin of Miscellaneous Information* for February contains an interesting report of the result of an inquiry on a point of some importance to the Excise, the presence of natural sugar in tobacco. It has been established that saccharine matter may be present in unadulterated Virginian tobacco to the extent of 15·2 per cent., and even in tobacco grown in this country to the extent of 9 per cent. Dr. Hugo Müller is of opinion that the sugar is not in the form of either lævulose or glucose, but that it is composed of at least three different carbohydrates which appear to be new to chemistry.

PRINCE BALTHASAR BONCOMPAGNI'S heirs have decided to sell his valuable library in the Palais Cenci, Rome. The library comprises more than eleven thousand different works, and will be sold *en bloc.* The Mathematical Section contains a very rare collection of works on arithmetic; and there are also numerous works on natural science and archæology in the library. Applications for catalogues should be sent to M. l'Avv. Francesco Sirani, 14 via del Nazareno, Rome.

THE thirty-third annual issue of that most useful publication, "The Statesman's Year-Book" (Macmillan), edited by Mr. Scott Keltie, with the assistance of Mr. J. P. A. Renwick, has just come to hand. A new feature, which will be much appreciated by the numerous people who consult the annual, is the insertion of four coloured maps, to illustrate the Anglo-Russian delimitation of the Pamirs, the Anglo-French arrangement with respect to Siam, the British Guiana and Venezuela boundary dispute, and recent arrangements in Bechuanaland.

A PAPER on the progress of science in England from the seventh to the thirteenth century inclusive, read before the Manchester Literary and Philosophical Society, appears in the number of the *Memoirs* of the Society just received (vol. x. No. 1, 1895–96). Other papers to which attention may well be directed are: "On Helium and its place in the Natural Classification of Elementary Substances," and "The Indefinite Quantitative Relations of the Physical and Chemical Forces," both by Dr. Henry Wilde, F.R.S., and an account of "Experiments on the Latent Heat of Steam," by Dr. J. A. Harker.

THE second volume of "Contributions to Canadian Palæontology" (*Geol. Surv. Canada*) consists of three papers on Arthropoda, by S. H. Scudder. Of these the most generally interesting one is that describing certain Myriapods and Scorpions from the famous hollow trunks of Sigillarians found in the coalfields of Nova Scotia. Another group of palæontological papers from the same region come from the *Transactions* of the Royal Society of Canada. They contain descriptions, by J. F. Whiteaves, of Cretaceous fossils from British Columbia, which afford some confirmation of Dr. Kossmat's views as to the distribution of Cretaceous land and sea, summarised some months back in these columns.

A DETAILED account of the Upper Palæozoic (Permian and Carboniferous) formations of Central Kansas, by C. S. Prosser, is to be found in the *Journal of Geology*, vol. iii. No. 7. The importance of this region in the general correlation of these beds has long been recognised, since here, unlike the Eastern States, coal is rare, and there is an almost unbroken series of marine strata from Carboniferous to Permian. The author shows that the Carboniferous brachiopod fauna does not extend as high as had previously been asserted, and that the higher beds contain a characteristic Permian lamellibranch fauna. He is thus able to draw a fairly definite line between Carboniferous and Permian (or Permo-Carboniferous), which he draws, for convenience of mapping, at the top of certain fossiliferous shales overlying the *Fusulina*-limestone. According to these views, Waagen, in his correlation of the Upper Palæozoic strata of India and of other countries, drew the base of the Permo-Carboniferous in the Western States too low; but this correction does not affect the general value of his correlation.

A NEW monthly review—the *Revue de l'Université de Bruxelles*—has made its appearance, its foundation being a sign of the era of prosperity and expansion inaugurated by the creation of the new institutes with which the "Université libre" has lately been endowed. The review is not to be the organ of any particular school of thought, but will include within its purview history, philosophy, science, social economy, and all branches of higher education. It is intended to be the focus of all the efforts made in the University world, and particularly in the Université libre de Bruxelles, for the advancement of science and study. The first two numbers of the new publication contain articles on penal law; great biological discoveries made during this century; the Botanic Garden at Buitenzorg; constitutional law; the work of Hittorf, Lenard, Goldstein, and Röntgen; and the International University Alliance.

THE twenty-sixth volume of the *Proceedings* of the London Mathematical Society, containing the papers read before the Society during the session 1894–95, has come to hand. In Mr. A. B. Kempe's presidential address, with which the volume opens, definitions of mathematics are discussed, and a new one formulated. According to dictionaries, mathematics is "the

science of number and magnitude," "the science which treats of the propertie and relations of quantities," or more briefly, "the science of quantity." Occasional definitions of a more comprehensive character are to be found scattered here and there in mathematical and other writings, but Mr. Kempe doubts whether any of them would satisfy a large body of modern mathematicians; therefore he suggests the following as a provisional definition: "Mathematics is the science by which we investigate those characteristics of any subject-matter of thought which are due to the conception that it consists of a number of differing and non-differing individuals and pluralities." Perhaps this definition will provoke some one to formulate another.

THE playgrounds of our public schools are said to be the arenas in which British battles are fought; and, in a similar sense, we may say that the scientific societies of our colleges are the training schools of scientific investigators. The system of compulsory games tends greatly to limit the time which public schoolboys can devote to natural history or other research, but a few enthusiasts contrive to gratify their curiosity to know something about natural facts and things. The twelfth annual report of the Felsted School Scientific Society testifies to the existence of this spirit of inquiry. Among the papers it contains, we notice one on "The Geology of Felsted," by Mr. J. French, and another on "Recent and Proposed Arctic Exploration," by Mr. J. F. Hartin. The Society used only to be concerned with natural science, but its field of operations has been enlarged, and its usefulness increased, by the creation of a Chemical Section. Stern methods are taken to keep up the attendances at the meetings, for we read: "That any member failing to attend at least one ordinary general meeting in each term in which such meetings are held, without reasonable excuse, be liable to ejection from the Society." It is appalling to think what would be the result of the application of this rule to many learned societies.

A LARGE number of students, as well as persons who do not pretend to possess any special scientific culture, will be glad to know that Tyndall's "Glaciers of the Alps" (Longmans, Green, and Co.), first published nearly six-and-thirty years ago, and for a long time out of print, has been reprinted. Upon Lord Kelvin's advice, no changes have been made in the controversial portions of the book, so the text has been left practically unaltered. Messrs. Kegan Paul and Co. have published a popular edition of Sir John Lubbock's standard work on "Seedlings," reviewed in these columns in January 1893 (vol. xlvii. p. 243). The parts included in the new volume are those of most general interest, and 282 of the 684 illustrations in the original work are used to elucidate the text. A new edition has been published of "Griffin's Electrical Engineers' Price-Book," edited by Mr. H. J. Dowsing. Nearly seventy pages of new matter have been added, and the whole of the prices have been brought up to date. Electrical and other engineers and contractors know that the volume is a ready and trustworthy means of reference to the prices with which they have to deal. The new and improved edition of "Historical and Future Eclipses," by the Rev. S. J. Johnson, just published by Messrs. James Parker and Co., will be appreciated as fully as the original little volume, which came out twenty-one years ago. The book is extremely handy, and contains not only a vast amount of interesting information with regard to eclipses of past and future time, but also notes on planets, double stars, and other celestial matters, thus making it valuable to practical astronomers.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*, ♂) from West Africa, presented by Miss Lilian Frost; two Black-backed Jackals (*Canis mesomelas*), a Puff Adder (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; a Condor (*Sarcorhampus gryphus*) from South America, presented by Mr. C. J. Wedderburn; a Guillemot (*Lomvia troile*), British, presented by Mr. J. L. Palmer; a Moorish Tortoise (*Testudo mauritanica*), from North Africa, presented by Mrs. Powell; a White-crowned Mangabey (*Cercocebus æthiops*, ♀) from West Africa, an Isabelline Lynx (*Felis isabellina*, ♂) from Ladakh, Cashmere, deposited; a Maguari Stork (*Dissura maguari*), a Guira Cuckoo (*Guira piririgua*), a Burrowing Owl (*Speotyto cunicularia*), a Brown Milvago (*Milvago chimango*), a Condor (*Sarcorhamphus gryphus*), a Boa (*Boa constrictor*) from South America, six Mexican Quails (*Callipepla squamata*) from Mexico, a Scarlet Tanager (*Ramphocœlus brasilius*), three Scarlet Ibises (*Eudocimus ruber*) from Para, a Ruff (*Machates pugnax*), two Redshanks (*Totanus calidris*), British, purchased.

OUR ASTRONOMICAL COLUMN.

VARIABLE STAR CLUSTERS.—The recent announcement by Prof. Pickering, of the discovery of variability in a large number of stars forming parts of star clusters (NATURE, vol. liii. p. 91), has led Dr. Belopolsky to examine some of the photographs of clusters taken at Pulkowa. Two photographs of the cluster M3 (N.G.C. 5272), in Canes Venatici, were taken in March 1894, and two more in April 1895. In the later photographs one sar was found to be two magnitudes brighter than in 1894, anddi fferences of brightness can also be traced in the case of other stars among the 1800 shown upon the photographs (*Ast. Nach.*, 3338). The Arequipa negatives of the same cluster indicated a variation of brightness in eighty-seven stars, amounting in some cases to at least two magnitudes.

THE SPOTS ON SATURN.—The inability of Prof. Barnard to detect any spots on Saturn with the aid of the Lick telescope may possibly have thrown some doubt upon the existence of such spots. Nevertheless, the observations of them by Mr. Stanley Williams have given such remarkably consistent results, that it is difficult to believe them illusory. In a recent article (*Observatory*, March, p. 112) Mr. Williams points out that there has been some misconception as to the nature of the Saturnian spots and the conditions for their satisfactory observation. While generally admitting the superiority of large telescopes, Mr. Williams holds that the spots on Saturn are such as to require a sight specially trained for their observation. The characteristics of the spots are (1) considerable size, (2) faintness, (3) extreme indefiniteness. The bright equatorial spots average about 2″ in diameter, while the dark spots on the broad double belt in the northern hemisphere have sometimes appeared as large as 4″ long by 2″ or 3″ broad. Similar spots have been noted by other observers, and the estimated positions have been sufficiently accordant to make it probable that the same objects were observed.

The planet will be in opposition on May 5, and it is to be hoped that the spots will receive the attention of observers. The spots appear to be best seen with low powers; with a power of 140 an equatorial spot has been observed to shine with almost stellar brightness, but with higher powers this peculiar brilliancy disappeared. Another point in Mr. Williams' experience is worth putting on record, namely, that in the south of England, at least, definition is usually much better about the time of sunset and for an hour afterwards than at other times.

COMPUTATION OF THE TIMES OF SOLAR ECLIPSES AND OCCULTATIONS.—In the *Revista do Observatorio* (Rio de Janeiro) for 1886, an account was given of a graphical method by which the approximate times of occurrences of solar eclipses and occultations, sufficiently accurate for first approximations, could be determined. Three years later, in a subsequent *Revista*, an application of this method to the eclipse of the sun of December 22, 1889, was made by Mr. Morize, of the Observatory of Rio. With the idea of making this method more general and applicable for all latitudes, the Director of the Observatory, Mr. L. Cruls, has published a short account of the method, simplified both as regards the computations and the graphical construction. The principle is based on the parallactic displacement of the moon in right ascension and polar distance, the values of which

have to be calculated for certain suitable and equidistant intervals of time. Knowing the hourly movements of the moon in right ascension and polar distance for the same instants from the almanack, and the elements of the phenomena, whether it be eclipse or occultation, the tracing of the positions of the bodies may be proceeded with. The plane of the drawing is supposed to represent that plane which is at right angles to the line joining the centre of the moon and the observer, at any one of the chosen instants near the time of conjunction of the two bodies. On this plane the successive projected true and apparent positions of the two bodies, sun and moon, or moon and star, are considered. The line passing through the centres of the moon in her different positions will thus represent the apparent lunar orbit, and if in addition we know the position at the moment of true conjunction of the two bodies, occupied by the centre of the sun or star, according as we are dealing with an eclipse or occultation, it will be easy to find the positions of the centres at the moments of contact, or of immersion and emersion, and also the times.

The calculation of the elements necessary for making the drawing would have for its aim the determination of the coordinates of the points of the apparent orbit occupied by the centre of the moon. This work is here rendered very easy by using the series of tables which have been prepared for reducing the calculation to a minimum. As an illustration showing the method of procedure, Mr. Cruls gives two complete worked-out cases, one of the eclipse of the sun at Rio de Janeiro April 16, 1893, and another of the occultation of α Virginis on March 22, 1894, at Greenwich. The accuracy of this graphical method may be gauged from the *observed* minus *calculated* values obtained in the two cases just mentioned.

		m.	
Eclipse of the sun	1st contact ...	−2·4	Observed—Calculated.
	2nd ,, ...	−0·3	
Occultation of α Virginis	Disappearance	+0·8	*Nautical Almanac*—Graphical Method.
	Reappearance	+1·2	

PENDULUM OBSERVATIONS IN GERMANY.

IT is a well-known fact that, at different places on the earth's surface and at the same sea-level, pendulums change their rates of swing. The numerous observations of von Sterneck, made in the region of the Alps, suggested that such deviations from the normal might be, and were most probably, explained on the supposition of unequal distributions of the masses in the neighbourhood—that is, either inside the mountains or in the earth's crust itself. Such observations as these indicated that good work might be done in this direction, and in consequence measurements were made on Mont Blanc, while in other directions observations were being organised by the scientific societies in Vienna, München, Leipzig, and Göttingen. The gravity determinations on Mount Blanc were made at the new observatory, and M. Jannsen informs us that besides those made in Chamounix in the previous summer, and on the Grands Mulets (3050 metres elevation), by M. Bigourdan, an effort will be made to continue them this summer on the summit itself. The results which have been obtained up to the present are as yet unpublished. A region which appeared full of interest for investigating the different rates of swinging pendulums is that in the region of Göttingen and the Harz Mountains. Prof. von Könen singled out what he thought were the three most suitable spots on account of their different geological conditions for such investigations, and observations at these stations were all compared with those made at Göttingen, this being the chief observing station on account of the observatory. It is true that the instrument employed in these determinations was far too rough for accurate and reliable measurements, it being the one which Dr. von Drygalski had previously used on his Greenland expedition, and with which Sterneck made his first experiments. The actual observations were made by Prof. Wilhelm Schur and Dr. Grossmann, and the results were communicated to the *Nachrichten der K. G. der Wiss. Gött.*, Heft 2, 1895. These may be summed up as follows. In the cases of the two stations at Grünenplan and Teichmühle, the very small differences when compared with Göttingen may be neglected when the kind of instrument employed be taken into consideration. The difference for the station Sack, on the other hand, was comparatively large, the numbers being—

For Grünenplan		Sack		Teichmühle
−0·00018	...	−0·00081	...	−0·00028

The conclusion drawn by Prof. von Könen from this somewhat rough determination was that the diminution in the intensity of gravity for the station Sack might possibly be due to the present condition of the positions of the underlying superposed strata (Schichtenüberschiebung).

Since the above determinations were made, the same ground has been covered, in September and October last, by Herr Haasemann, who, at the request of Geheimrath Helmert, undertook to make a series of measurements at the same observing stations as used by Prof. Schur. In this new investigation the instruments employed were more accurate and of later design, so that the results may be looked upon as more trustworthy and accurate. Limiting ourselves to giving the actual numerical results, the differences for the three stations when compared as before with Göttingen were—

For Grünenplan		Sack		Teichmühle
+0·00007	...	−0·00003	...	−0·00011

Comparing these figures with those obtained by Prof. Schur, the large difference for Sack entirely disappears. This indicates that at these places the determinations of the rates of the pendulums give no trace of any variation in the intensity of gravity, or at least of any variation which is capable of being detected by the apparatus employed. D.

PETROLEUM LAMP ACCIDENTS.

THE report of Mr. Alfred Spencer, chief officer of the Public Control Department of the London County Council, as to the causes of petroleum lamp accidents, and as to the measures necessary for preventing them, which has just been issued, is an important document. The number of accidents due to the use of cheap and unsafe petroleum lamps has assumed alarming proportions within the past few years, that the means by which the accidents can be prevented cannot be too prominently or too frequently brought before the public. Mr. Spencer has made a thorough investigation with numerous lamps and stoves in which petroleum is used, in order to determine the conditions of safety. The results of his experiments lead him to conclude that raising the flash-point fixed by the Petroleum Acts would not alone be effectual in preventing lamp accidents, as this would not prevent the sale and use for illuminating purposes of oil below that flash-point. He remarks, however, that the prohibition of the retail sale, and the prevention of the use for illuminating purposes of mineral oil below a flashing-point sufficiently high to prevent all lamp accidents, would be effectual if it were practicable. The prohibition by statute of the sale of unsafe lamps would be another means of putting an end to lamp accidents, as both experience and experiment have proved that mineral oils, such as are now in common use, can be safely burnt in properly constructed lamps. The difficulties in the way of prohibiting the sale of unsafe oil are far greater than would be met in regulating the construction and sale of safe lamps; therefore Mr. Spencer suggests that the latter is the means of safety which should be enforced by order of the Secretary of State. His suggestions for the safe construction and proper management of lamps, revised in the light of recent experiments, are as follows:—

CONSTRUCTION.

(1) The oil reservoir should be of strong metal, properly folded and soldered at the joint, and should not be of china, glass, or other fragile material.

(2) There should be no opening between the reservoir and the burner, other than through the tube which holds the wick; and this tube should be extended to within ¼ in. of the bottom of the reservoir, and should have no opening into the reservoir except at its base.

(3) The burner should be securely attached to the reservoir, preferably by means of a strong and well-made screw attachment.

(4) There should be no openings through which oil could flow from the reservoir should the lamp be upset.

(5) Every table lamp should have a broad and heavy base, to which the reservoir should be strongly attached.

WICKS.

(6) Wicks should be soft, and not tightly plaited, and should quite fill the wick-tube without having to be squeezed into it.

(7) Wicks should be frequently renewed, and before being put into lamps should be dried at a fire and then immediately soaked with oil.

Management.

(8) The reservoir should be filled with oil before the lamp is lit.

(9) The lamp should be kept thoroughly clean, all oil should be carefully wiped off, and all charred wick and dirt removed before lighting.

(10) When first lit the wick should be partially turned down, and then gradually raised.

(11) The wick should not be left turned down, as there is then a greater liability to explosion in lamps of unsafe construction.

(12) Lamps which have no extinguishing apparatus should be put out as follows:—The wick should be turned down until there is only a small flickering flame, and a sharp puff of breath should then be sent across the top of the chimney, but not down it.

(13) Cans or bottles used for oil should be free from water and dirt, and should be kept thoroughly closed.

Note.—These suggestions apply to ordinary petroleum or paraffin lamps such as are generally used, and not to benzoline or spirit lamps.

FORTHCOMING SCIENTIFIC BOOKS.

We print below a list of books on science promised for publication during the spring season:—

Messrs. Swan Sonnenschein and Co., Limited, announce:—Analytic Psychology, by G. F. Stout, 2 vols.; Outlines of Logic and Metaphysics, by Johann Eduard Erdmann, translated from the fourth German edition, with a prefatory essay, by Dr. B. C. Burt; An Introduction to the Study of Philosophy, by Prof. Oswald Külpe, translated under the supervision of Prof. E. B. Titchener; Text-book of Palæontology for Zoological Students, by Theodore T. Groom, fully illustrated; The Indian Calendar, with Tables for the Conversion of Hindu and Muhammedan into A.D. dates and *vice versâ*, by Robert Sewell, with Tables of Eclipses visible in India, by Dr. Robert Schram; Practical Plant Physiology, by Prof. Wilhelm Detmer, translated by S. A. Moor; Introduction to the Study of Organic Chemistry, by J. Wade; Fishes, by the Rev. H. A. Macpherson; Mammalia, by the Rev. H. A. Macpherson; Birds' Eggs and Nests, by W. C. J. Ruskin Butterfield; Mosses, by J. E. Bagnall, fourth edition; The Dynamo, how Made and how Used, by S. R. Bottone, ninth edition; Geometry for Kindergarten Students, by Adeline Pullar, 499 illustrations.

Messrs. Cassell and Co., Limited, give notice of Cottage Gardening, Poultry, Bees, Allotments, Food, House, Window and Town Gardens, edited by W. Robinson, fully illustrated and containing coloured plates, half-yearly volume; new volumes of the "Century Science" Series, edited by Sir Henry Roscoe, F.R.S.:—Sir Humphrey Davy, by T. E. Thorpe, F.R.S.; J. Clerk Maxwell and Modern Physics, by R. T. Glazebrook, F.R.S.; Birds' Nests, Eggs, and Egg Collecting, by R. Kearton, illustrated; Lessons in Carpentry Workshop Practice, by Charles F. Mitchell, new and revised edition; Cassell's Gazetteer of Great Britain and Ireland, with numerous illustrations and maps in colours, vol. iii.; The Countries of the World, by Dr. Robert Brown, profusely illustrated, vol. ii. of the cheap edition; The World of Wonders, illustrated, vol. i. of the cheap edition; Science for All, illustrated; Cassell's Concise Cyclopædia, illustrated.

Messrs. Macmillan and Co., Limited, will publish Miscellaneous Papers by Heinrich Hertz, with an introduction by Prof. Philipp Lenard, authorised English translation by D. E. Jones and G. A. Scholt; Studies in the Art Anatomy of Animals, being a brief analysis of the visible forms of the more familiar mammals and birds, designed for the use of sculptors, painters, illustrators, naturalists, and taxidermists, by Ernest E. Thompson; Text-book of Comparative Anatomy, by Dr. Arnold Lang, translated into English by Henry M. Bernard and Matilda Bernard, part ii.; Macmillan's Geography Readers, book v., Europe, book vi., the Colonies of Great Britain, illustrated; A System of Medicine, by many writers, edited by Thomas Clifford Allbutt, F.R.S.; Domestic Science Readers, by Vincent T. Murché, for standards i.–vi.; Science Class Books:—Physics for Medical Students, by Alfred Daniell; the Scenery of Switzerland, by Sir John Lubbock, Bart., F.R.S.; a Dictionary of Chemical Solubilities, Inorganic, by Dr. Arthur Messenger Comey; the Theory of Sound, by Lord Rayleigh, F.R.S., vol. ii., second edition, revised and enlarged.

The Cambridge University Press has in preparation:—The Collected Mathematical Papers of the late Arthur Cayley, F.R.S., to be completed in thirteen volumes, vol. ix.; An Introductory Treatise on the Lunar Theory, by Prof. E. W. Brown; The Scientific Papers of John Couch Adams, F.R.S., vol. i., edited by Dr. William Grylls Adams, F.R.S.; A Treatise on Abel's Theorem, by H. F. Baker; Cambridge Natural Science Manuals, Biological Series, general editor, A. E. Shipley; Elementary Palæontology, Invertebrate, by H. Woods, new edition; A Manual of the Phanerogams and Ferns, Morphology, Natural History and Classification, alphabetically arranged by J. C. Willis; Physical Series, general editor, R. T. Glazebrook, F.R.S.; Electricity and Magnetism, by R. T. Glazebrook, F.R.S.; Cambridge Geographical Series, general editor, Dr. F. H. H. Guillemard; Geographical Distribution of Mammals, by R. Lydekker, F.R.S.

Mr. W. B. Clive (University Correspondence College Press) announces:—A Manual of Psychology, by G. F. Stout; A Manual of Logic, by J. Welton, complete in 2 volumes, vol. i., 2nd edition; Questions on Welton's Logic, with Illustrative Examples, by H. Holman, Key to Holman's "Questions on Welton's Logic"; A Primer of Logic, by J. Welton; Euclid, Books i.–iv., by Rupert Deakin; Deductions in Euclid, by T. W. Edmondson and J. Briggs; Geometrical Conic Sections, Co-ordinate Geometry, part ii, A Higher Text-book of Dynamics, A Higher Text-book of Hydrostatics, each by Dr. G. H Bryan, F.R.S.; Key to the Elementary Mechanics of William Briggs and G. H. Bryan, F.R.S.; The Tutorial Trigonometry, An Intermediate Text-book of Statics, An Intermediate Text-book of Dynamics, The Tutorial Algebra, each by William Briggs and Dr. G. H. Bryan, F.R.S.; The Properties of Matter, an Introduction to the Tutorial Physics, by E. Catchpool; Inorganic Chemistry, First Stage; A Synopsis of Non-Metallic (Inorganic) Chemistry, by William Briggs, 4th edition, revised by W. Hurtley; A Synopsis of Metallic Chemistry, by W. Hurtley; The Tutorial Chemistry, by Dr. G. H. Bailey; part i. Non-metals; part ii. Metals; Magnetism and Electricity, First Stage; Sound, Light and Heat, First Stage, by John Don.

Messrs. Crosby Lockwood and Son's announcements are:—Light Railways for the United Kingdom, India, and the Colonies: a Practical Handbook on their Construction, Equipment, &c., by J. C. Mackay; Nitro-Explosives: a Practical Treatise on their Manufacture, Properties, and Analysis, by P. Gerald Sanford; Colliery Working and Management: comprising the Duties of a Colliery Manager, and the Different Systems of working Coal Seams, by H. F. Bulman and R. A. S. Redmayne; The Detection and Estimation of Inflammable Gas and Vapour in the Air, by Prof. Frank Clowes, with a chapter on the Detection of Inflammable Petroleum-Vapour, by Boverton Redwood; Handy General Earthwork Tables, by J. H. Watson Buck; a fourth edition of F. W. Simms's Practical Tunnelling, revised and greatly extended, with additional chapters illustrating recent practice, by D. K. Clark; and a new edition of Warn's The Sheet Metal Worker's Instructor, rewritten and greatly extended by J. G. Horner.

Mr. John C. Nimmo promises The Flora of the Alps, being a description of all the species of flowering plants indigenous to Switzerland, and of the Alpine species of the adjacent mountain districts of France, Italy, and Austria, including the Pyrenees, by Alfred W. Bennett, with 120 coloured plates, 2 vols.; A Natural History of British Moths, by the Rev. F. O. Morris, fourth edition, with an introduction by Dr. W. Egmont Kirby, and 132 plates coloured by hand, 1933 figures of moths; A History of British Birds, by the Rev. F. O. Morris, in 36 monthly parts, vol. ii., containing 7–12, with 69 plates coloured by hand.

Messrs. Sampson Low, Marston, and Co., Limited, are preparing:—Text-book of Zoology, by Dr. J. E. V. Boas, translated by J. W. Kirkaldy and E. C. Pollard, illustrated; Short Studies in Physical Science, by Vaughan Cornish, with four plates; Handbook of Arctic Discoveries, by General A. W. Greely, with portrait and maps; The Land of an African Sultan, Travels in Morocco, by Walter B. Harris; The Wild North Land, by General Sir W. F. Butler; Textile Calculators, by E. A. Posselt; Health and Condition in the Active and the Sedentary, by N. E. Yorke-Davies, third edition, revised and enlarged.

Messrs. A. and C. Black promise Artistic and Scientific Taxidermy and Modelling, by Montagu Browne; Text-book of General Pathology and Pathological Anatomy, by Prof. Thoma,

translated by Dr. Alexander Bruce, 2 vols; Plea for a Simpler Life, by Dr. George S. Keith, fifth edition; The Evolution of Bird-song, with observations on the influence of heredity and imitation, by Charles A. Witchell.

Messrs. Smith, Elder, and Co.'s list is as follows:—The Spas and Mineral Waters of Europe, with Notes on the Utility of Spa Treatment in various Diseases and Morbid Conditions, by Drs. Hermann Weber and Frederick Parkes Weber; The Treatment of Phthisis, by Arthur Ransome, F.R.S.

Messrs. G. P. Putnam's Sons' announcements include:—The Evolution of Horticulture in New England, a History of the Art of Gardening in New England from its earliest plantation to the present day, by Daniel Denison Slade; A Scientific Demonstration of the Future Life, by Thomson Jay Hudson; Handbook for Hospitals, a manual of practical suggestions, by Abby Howland Woolset.

Messrs. W. H. Allen and Co., Limited, will publish Allen's Naturalists' Library, edited by Dr. R. Bowdler Sharpe, illustrated; British Birds, vols. iii. and iv., by the editor; Butterflies, vol. ii. by W. F. Kirby; Game Birds, vol. ii., by W. R. Ogilvie Grant.

Mr. Young J. Pentland's list contains:—Atlas of the Fundus Oculi, illustrated with figures in colours by W. Adams Frost; The Principles of Treatment, by Dr. J. Mitchell Bruce; The Edinburgh Hospital Reports, vol. iv.; a new edition of Prof. Cunningham's Manual of Practical Anatomy, in 2 vols., with additional illustrations.

Mr. Wm. F. Clay, Edinburgh, has in the press:—The Histopathology of the Diseases of the Skin, by Dr. P. G. Unna, translated from the German with the assistance of the author by Dr. Norman Walker, with double coloured plate containing nineteen illustrations and forty-two additional illustrations in the text.

Mr. Erwin Nägele, Stuttgart, announces Researches on Mimicry on the basis of a Natural Classification of the Papilionidæ, by Dr. E. Haase, translated by Dr. C. M. Child, with eight coloured plates, 4to, part ii.

Messrs. Whittaker and Co. will publish immediately:—Future Trade in the Far East, by C. C. Wakefield, fully illustrated, and containing a map showing the latest developments in the trade routes.

The Rebman Publishing Company, 11 Adam Street, Strand, W.C., have ready for immediate publication, Water and Water Supplies, by Dr. J. C. Thresh.

Mr. F. Furchheim, Naples, announces Bibliografia del Vesuvio e del suo Territorio, compiled by Federigo Furchheim.

Mr. David Douglas (Edinburgh) will issue The Vertebrate Fauna of Scotland, vols. vi. and vii.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE recent decision of the Supreme Court of the United States in favour of Mrs. Stamford, and adverse to the Government in its claim for 13,000,000 dollars, means the salvation of the Leland Stamford Junior University, at Palo Alto, California; as Mrs. Stamford will now be able to carry out the munificent plan of endowment, which has been held in abeyance pending the issue of this litigation. The Johns Hopkins University at Baltimore, on the contrary, is seriously crippled by the collapse of the Baltimore and Ohio Railroad system, which has just been put into the hands of a receiver. The University held a large amount of the securities of this line.

THE County Council of Southampton has decided not to levy a rate of a halfpenny in the pound, under the Technical Instruction Act, which had been recommended by the Finance Committee with a view of assisting the Hartley Institution, a school of science and art, in that town. As far as we can gather, Southampton is suffering from a plethora of educational authorities. Besides the Council of the above institution, the Endowed Schools governors and the School Board are also engaged in providing different grades of technical education.

WE notice that on Monday, the 16th inst., a deputation of the Lancashire Committee of the Incorporated Association of Head Masters waited upon the Technical Instruction Committee of the Lancashire County Council, to urge the claims of the secondary schools in the county upon the Committee. They based their claims upon the admitted imperfect education of the students who presented themselves at the technical schools for instruction, urging that the want of proper preliminary education could be avoided by a liberal offering of scholarships to the secondary schools, which out of the increased income resulting from the augmentation of numbers, could easily ensure a satisfactory introductory training for the future students. Attention was also very properly called to the work of this kind which had been carried out in other counties. Though the chairman expressed a fear that want of funds would prevent very much being done for secondary schools, we are sure, in view of his admission that the Committee agreed that these schools were the proper places for much of the early work in a good system of technical education, that it will not be long before the Lancashire authority does something to meet the claims urged by the deputation.

THE latest report of the Technical Instruction Committee of the Derbyshire County Council is very refreshing reading. The pamphlet is prefaced by an explanation of what the Committee considers to be the proper scope of technical education. It is rightly affirmed that a complete system has two main objects: (1) to provide for those who may naturally be expected to occupy positions of control, *i.e.* the "managers"; (2) to provide for the class from which individuals are constantly rising to positions of control, *i.e.* the "men." Recognising that the recent industrial developments of Germany are in a very large measure due to the scientific training of the managers and foremen, the Derbyshire Committee very early turned its attention to the secondary schools, as being the institutions where this class receives its early education. Very much has been done to improve the standard and nature of the instruction given in the grammar schools of the country. In giving help to these educational establishments it has in every case been insisted upon that it is desirable only to give a general education in English and languages, and to add a solid groundwork of mathematics, drawing, and pure science, without dealing with their application to specific industries. At the same time it has not been lost sight of that those students who will naturally pass on to occupy positions of high responsibility, must receive special courses of instruction at technical schools and higher educational institutions. In dealing with the requirements of the "men," the Committee have wisely decided that the teaching in elementary schools is best supplemented by a course of object-lessons in elementary science. To ensure this being well done, classes for elementary school teachers have been organised, with a view to teaching them how to give instruction in this way. The scholar's education can then be suitably continued in evening schools and science and art classes, which have been arranged in each district according to its needs. For the more advanced study which is necessary for most of the first class of students and for a considerable proportion of the second, who themselves desire it, a technical school is naturally stated to be of great importance. Instead of attempting to found such an institution themselves, the Committee have decided that the wisest course is, by a careful system of grants, scholarships, and exhibitions, to utilise the excellent colleges of Nottingham, Sheffield, Manchester and Derby, which all border upon their administrative county.

In addition to the above work, we would especially notice the initiation of the Midland Dairy Institute, the inauguration of a Department of Mining at Firth College, Sheffield, the establishment of local classes in "hosiery" at Heanor, in "calico printing, bleaching, &c.," at New Mills, and in the principle of design at various centres. The year's work is a decidedly successful one, and we hope to see several other counties following the logical and scientific methods of procedure which the Derbyshire Committee have laid down.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for February, 1896, contains:—On the early development of Amia, by Bashford Dean (Plates 30–32). *Amia calva*, possibly the sole survivor of the race of the Mesozoic Ganoids, claims our special interest as the nearest ancestral form of some, if not of all, of our recent Teleosts. In embryology the Ganoid and the Teleost still stand widely separate; there has even been a tendency to look upon these kindred forms as representing different phyla, early divergent from a primitive chordate ancestor. This, therefore, renders the details given by Dr. Dean

of special interest. About the general habits of this fish, he thinks it unnecessary to write much, as Fülleborn's notes, so recently published, are but confirmed; but we are glad that he has added some on the breeding habits, which are illustrated with sketches of the nest and of the cloud of young fry attended by the male. The author concludes that the early development must certainly be regarded as furnishing abundant evidence of intermediate characters; to the Ganoids, on the one hand, and to the Teleosts, on the other. These ontogenetic nearnesses become, accordingly, of the greatest interest, since they confirm the results of the structural study of recent and fossil forms upon the Amioid descent of Teleosts.—On *Kynotus cingulatus*, a new species of earthworm from Imerina in Madagascar, by W. Blaxland Benham (Plates 33 and 34). This interesting species is remarkable for the great number and small size of the segments composing the body; there were three anterior portions sent for examination, each about 225 mm. in length; each piece consisted of some three hundred or more segments; the whole worm being probably about 450 mm. to 500 mm. in length; it possesses a clitellum of relatively enormous dimensions, with most peculiar "claspers."—Notes on the ciliation of the ectoderm of the amphibian embryo, by R. Assheton (Plate 35), describes the distribution of the cilia over the surface of the bodies of the tadpoles of *Rana temporaria and Triton cristatus*. As the author notes, the existence of a ciliated embryo among craniate vertebrates seems often to be overlooked.—On the ontogenetic differentiations of the ectoderm in Necturus (Study II.).—On the development of the peripheral nervous system, by Julia B. Platt (Plates 36–38). Even if we assume Necturus to be a monotypic genus, it would have been advisable for the authoress to have cited a specific name for the Batrachian, whose peripheral nervous system she has so painstakingly elaborated. The summary, occupying two pages, is too long to be cited, and does not admit of being further condensed; we note that "although delicate protoplasmic prolongations connecting cell with cell initiate the specialised coordination of the nervous system, a common reticulum, such as Sedgwick describes, into which nuclei migrate, does not exist in *Necturus*" [*lateralis*]. This number contains a title and index to Volume xxxviii.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 13.—"On the Behaviour of Argon and Helium when submitted to the Electric Discharge." By Dr. J. N. Collie and Prof. William Ramsay, F.R.S.

Some years ago, Natterer published the results of experiments on the passage of electricity through various gases and vapours at the ordinary atmospheric pressure; he found that the length of the spark, or the "spark-gap" varied in length in a manner approximately proportional to the number of atoms in the molecule of the gas; thus in mercury gas the distance was very much greater than that obtained in hydrogen, oxygen, nitrogen, or other diatomic gases; and in these, the spark-gap was longer than in substances of more complex molecular constitution.

Experiments of a similar nature, carried out by us on some common gases and on argon and helium, gave the results which are summarised in the following table:—

	mm.
Oxygen	23·0
Air	33·0
Hydrogen	39·0
Argon	45·5
Helium	Probably 250 or 300

The current was of constant potential and quantity; and the hammer of the coil was kept in a constant position during the experiments. Indeed, on re-testing the spark-gap with air, after the experiments were finished, the original number was reproduced.

On lowering pressure, this spark-discharge changes into a ribbon-like discharge, before the "fluffy" appearance of a so-called vacuum tube becomes visible. It appeared that this change, occurring at a definite pressure, might be measured with fair accuracy. The results of a series of such experiments is to show that the character of the discharge changes for the under-mentioned gases at the pressures stated:—

	mm.
Air	73 or 74
Hydrogen	42 ,, 43
Oxygen	81
Carbon dioxide	92 or 94
Cyanogen	23
Nitrogen	33
Carbon monoxide	49
Helium	1270

A tube filled with helium shows all the phenomena of a vacuum tube when containing the gas at atmospheric pressure.

The visibility of the spectrum of one gas in presence of another was next investigated. For a full description of the method of filling the tubes, and altering the pressure, the original paper must be consulted. Only the final results are here reproduced.

Amount of Gas detectable in a Mixture.

	Per cent.	
(1) Helium in hydrogen	33	of helium invisible at 2·61 mm.
	10·9	,, barely visible at the lowest pressure.
(2) Hydrogen in helium	0·001	visible at all pressures.
(3) Nitrogen in helium	0·01	almost invisible.
(4) Helium in nitrogen	10	of helium difficult to detect.
(5) Argon in helium	0·06	still visible at all pressures.
(6) Helium in argon	33	invisible at 2·62 mm. pressure.
(7) Nitrogen in argon	25	,, 2·58 ,, ,,
	0·42	,, 1·7 ,, ,,
	0·08	,, 0·18 ,, ,, though just visible at 1·05 mm.
(8) Argon in nitrogen	37	barely visible at any pressure.
(9) Argon in oxygen	2·3	difficult to distinguish at 1·04 mm. pressure.

From these experiments it appears that at high pressures, a discharge passes much more readily through helium than through other gases; but at a low pressure, if passage of current can be inferred from luminosity of spectrum, all other gases convey current more readily than helium does; and nitrogen conveys current more readily than argon. This is probably connected with the known fact that decrease of pressure promotes dissociation. The experiments on the relative luminosity of these gases were made with electrodeless tubes, hence it cannot be objected that the passage of current is determined by the attraction of the material of the electrodes for the gas under experiment.

"On the Absorption of the extreme Violet and ultra-Violet Rays of the Solar Spectrum by Hæmoglobin, its Compounds, and certain of its Derivatives." By Dr. Arthur Gamgee, F.R.S., Emeritus Professor of Physiology in the Owens College, Victoria University.

The investigation, of which the chief results are communicated in this paper, had for its starting-point the observation of the late Prof. J. L. Soret, of Geneva, who showed that, in addition to the absorption bands in the visible spectrum, solutions of the blood-colouring matter are characterised by an intense absorption band in the extreme violet between G and H. The present research has been conducted with the aid of photography, quartz prisms and lenses being employed.

The following are some of the principal results of the investigation:—

I. The compounds of hæmoglobin with oxygen, carbonic oxide, and nitric oxide present, even in highly dilute solutions, an absorption band between Fraunhofer's lines G and H. In the case of oxy-hæmoglobin the mean ray absorbed coincides with λ 414·0, that is to say, the centre of absorption is slightly nearer the red end of the spectrum than Soret had stated; this observer placed the centre of absorption at *h* (λ 410·1). As Soret had indicated, in the case of the compound of carbonic oxide with hæmoglobin, the absorption band is slightly displaced towards the less refrangible end of the spectrum. The combination of hæmoglobin with nitric oxide presents an absorption band occupying precisely the position of that of the CO-compound. In the case of these two compounds, the mean ray absorbed corresponds to λ 420·5.

II. When the molecule of *dissociable* oxygen is removed from oxy-hæmoglobin, either by the action of reducing agents, or by boiling *in vacuo*, the absorption band in the extreme violet is remarkably displaced towards the less refrangible end of the spectrum, the centre of absorption corresponding to λ 426·0.

III. The absorption of the extreme violet depends on the iron-containing moiety of the hæmoglobin molecule, for, whereas it is not presented by the albuminous product of the decomposition of the blood-colouring matter, it is characteristic of the acid compounds of hæmatin and of hæmochromogen.

IV. Solutions of alkaline hæmatin, even when enormously diluted (1 : 30,000 of water), exert a general absorption of the ultra-violet and extreme violet, but present no trace of definite absorption, either in the extreme violet or the adjacent ultra-violet region.

The compounds of hæmatin with acids, *e.g.* hæmatin hydrochloride, present even in solutions of great dilution (1 : 25,000—1 : 50,000) an intense absorption band, which encroaches more and more on the ultra-violet as the strength of the solution increases. With a solution containing one part of crystallised hæmatin hydrochloride in 20,000 parts of glacial acetic acid the band extends between *h* and M, the most intense absorption being between *h* and L. In highly dilute solutions the band which is still intense absorbs both H and K.

V. Solutions of hæmochromogen (reduced hæmatin of Stokes) exhibit an intense absorption band between *h* and G. The band has the same position as the band of CO-hæmoglobin, but is more intense. From the examination of solutions of various strengths, it results that the mean ray absorbed corresponds to λ 420·0.

VI. The absorption of the extreme-violet and ultra-violet by methæmoglobin indicates that this body is the product of a partial decomposition of the molecule of oxy-hæmoglobin.

VII. The band in the extreme-violet (and ultra-violet), which is characteristic of hæmoglobin, its compounds, and certain of its iron-containing derivatives, in no respect depends upon the iron in the molecule. This conclusion is based (1) on the fact that none of the compounds of iron, organic or inorganic, possess the property of producing a definite absorption in the extreme-violet or the adjacent ultra-violet; (2) upon the study of hæmatoporphyrin, a body derived from hæmatin by the removal of the iron which this body contains.

Acid solutions of hæmotoporphyrin of extreme dilution exhibit an absorption band between *h* and H. If the solution be slightly more concentrated K is absorbed, and with increasing concentration of the solution the absorption of the ultra-violet extends more and more. Alkaline solutions of hæmatoporphyrin absorb the same spectral region, but the intensity of the absorption is greater.

VIII. Neither bilirubin, hydrobilirubin, nor urobilin present any definite absorption band in the region of the spectrum, where the absorption band of hæmoglobin and its derivatives occurs.

Physical Society, March 13.—Prof. Carey Foster, Vice-President, in the chair.—Mr. J. H. Reeves read a paper on an addition to the Wheatstone's bridge for the determination of low resistances. The piece of apparatus described can be used for measuring the resistance of metre lengths of wires of low resistance, the only additional apparatus required being a sensitive galvanometer, a Post Office form of resistance box, and a metre bridge. It differs from the ordinary Kelvin bridge in that instead of balancing by varying the length of the standard wire between the two contacts, the distance between these contacts is maintained constant, as is also the length of the wire which is being measured, and balance is obtained by altering other resistances in the network. The author has made a number of tests which show that by his arrangement the resistance of metre lengths of copper wires between the limits of No. 22 S.W.G. and a stranded cable of 7 No. 16's can be determined with an accuracy of 0·1 per cent.—Mr. Reeves also read a note on the exact value of Matthiessen's standard. Prof. A. Gray (communicated) said that the author had in his arrangement combined the fixed standard employed in Matthiessen and Hocking's modification of the ordinary bridge with the greater celerity of working arising from the smaller number of operations to be performed when the Kelvin bridge is used. Prof. Gray thinks that he, and probably others, used a method similar to that of Mr. Reeves; but that the paper is of great utility, since it shows how time may be saved and existing apparatus utilised. Prof. Ayrton said that the advantage of the method described lay in the fact that it was independent of the resistances at the contacts. In Carey Foster's method, however, the coils had to be interchanged, and inaccuracy might be introduced owing to the varying resistance of the mercury contacts. Unless the mercury cups and the copper plates at the bottom were cleaned every day and the contacts re-amalgamated, the resistance of the mercury cups was very variable. With regard to the question of Matthiessen's standard, it is to be remembered that the specific conductivity of copper has been steadily increasing. This increase was particularly noticeable in the copper prepared by the Elmore process, where, during the deposition of the metal, an agate burnisher is kept continually passing over the surface. Fitzpatrick had explained the rise in conductivity of copper by supposing that the density of the copper now supplied was greater than that of the copper used by Matthiessen, and this explanation seemed quite satisfactory. Mr. Reeves's experiments, however, have conclusively shown that this is not the true explanation. It was now possible to obtain copper in large quantity having a conductivity of 103 on Matthiessen's scale. The Chairman (Prof. Carey Foster) explained how, when using his method, the accuracy of the result depends not on the elimination of the small resistances at the mercury cups, but on the constancy of these resistances. Matthiessen and Dr. Russell found that the specific gravity of copper was apt to be low on account of the presence of dissolved oxide, and they were the first to pass hydrogen gas through the molten metal to remove this oxide. Mr. Appleyard gave a simple diagramatic sketch of the author's arrangement, and also pointed out that better results would probably be obtained with a galvanometer of one or two ohms resistance. Mr. Campbell said that it ought to be definitely settled whether Matthiessen's standard was the conductivity per unit volume or per unit mass. Since copper was always bought by weight, he, as a practical man, strongly advocated the adoption of the mass conductivity; further, in this case the measurement of the specific gravity would be avoided. Mr. Reeves having replied, a communication by Herr Puluj on kathode rays was read by the Secretary.—Herr Puluj exhibited some Röntgen photographs taken by means of a form of Crookes' tube, which he had described in a memoir published in 1889. With this tube he has succeeded in obtaining impressions with exposures of only two seconds. Herr Puluj considers that the particles of matter torn from the kathode, which convey negative electrostatic charges, by impact on the glass walls, or on screens, equalise their electric charges, and in this process call forth not merely a disturbance of the material molecules, but also of their ether envelopes. Each portion of the glass or screen bombarded by the kathode stream becomes the starting-point of ether waves, which, according to their oscillation period and oscillation character are either visible rays (phosphorescence) or invisible Röntgen rays. The oscillations of the invisible rays may take place in the longitudinal direction, but no convincing argument has up to now been brought forward to support this view.—The Secretary also read a note on permeability to Röntgen rays, by Messrs. Ackroyd and Knowles. The authors have exposed a plate on which a number of pieces of metal, oxides, and sulphates were placed to the Röntgen rays in order to see whether the permeability of bodies to these rays depends on the atomic or molecular weight of the body. In each case it was found that the opacity increased with the molecular weight. Mr. Blakesley said that he considered the Röntgen rays to be the propagation of electrostatic strain through space. With reference to the non-refrangibility of these rays, he had observed in one of the photographs, exhibited by Mr. Swinton, a dark line at the edge of the shadow of a wooden pencil, which might have been due to the refraction of the rays by the wood. Mr. Blakesley has, however, found that this line is due to the varnish on the pencil. Some Röntgen photographs of quartz and ebonite rods not only did not exhibit these dark lines, but there was a very slight indication of a bright line just on the edge of the shadow, which would indicate that the refraction of these rays was less in the rods than in the surrounding medium.—Mr. Edser exhibited some photographs taken with Mr. Jackson's form of tube, in which a concave kathode is employed. Mr. Edser said that the whole of the tube on the kathode side of the anode plate phosphoresced, so that the Röntgen rays seem to partake of the character of diffused light. Prof. Ayrton said Mr. Jackson had found that the kathode rays form a parallel beam and do not first come to a focus and then again spread out. The Chairman said that some observations made by Mr. Porter agreed with those of Mr. Edser. Mr. Blakesley described the tube used by Puluj, in which a mica screen coated with green calcium sulphide is placed between the kathode and the anode. Mr. Gardner said that there seemed to be some confusion, for when a concave kathode is employed, the kathode rays are brought to a focus and then again diverge. The phosphorescence on the inside of the glass had been shown by Lenard to be due to electricity travelling round the inside surface of the glass. Mr. Pidgeon asked if any one had tried the effect of mounting the photographic film on a metal plate. The Chairman said that Captain Abney had found that if the film was

mounted on a ferrotype plate no action took place. Prof. Perry said that he, for one, was of opinion that the Röntgen rays were undulatory. Prof. Larmor has given an explanation which seems to agree with the observed facts. This explanation supposes that the intermolecular spaces respond to vibrations of a certain frequency. The reason no refraction or diffraction effects had been observed was probably because of the extreme smallness of the wave-length of the undulation.—After a few further remarks by some of the members, the Society adjourned till March 27.

PARIS.

Academy of Sciences, March 9.—M. A. Cornu in the chair.—On the divergence of trigonometrical series, by M. H. Poincaré. A reply to some remarks by M. Hill.—On some new properties of the invisible radiations emitted by some phosphorescent bodies, by M. Henri Becquerel. The rays emitted by potassium uranyl sulphate, which has been kept in the dark for some days, are capable of discharging a gold leaf electroscope even after passing through a plate of aluminium 2 mm. in thickness. Clear evidence was obtained that these invisible rays are capable of reflection and refraction.—On the use of artificial hexagonal blende in the place of a Crookes' tube, by M. Troost. By means of the light given off by a crystal of artificial blende, rendered phosphorescent by exposure to burning magnesium ribbon, good images of metallic objects upon a sensitised plate were obtained, the rays passing through blackened paper readily. The effects produced are the same as with a Ruhmkorff coil and Crookes' tube. The time of exposure is not given.—On some conditions which govern gaseous combinations. The combination of oxygen and hydrogen at low temperatures, by MM. A. Gautier and H. Helier. By circulating the gaseous mixture through a porcelain tube packed with porcelain rods, kept at a constant temperature, and then passing the products over tubes containing phosphoric anhydride, combination can be shown to occur at as low a temperature as 180° C., explosions not occurring until about 840° C.—On the carbides of yttrium and thorium, by MM. H. Moissan and Étard. Yttrium carbide, prepared in the electric furnace, is attacked readily by the halogens, with difficulty by acids. With water the carbide yields a mixture of acetylene (72 per cent.), methane, ethylene, and hydrogen, together with a small quantity of liquid hydrocarbons. Thorium carbide, produced by a similar method, forms a crystalline transparent mass, and gives a mixture of hydrocarbons on treatment with water of the same qualitative composition as that obtained from yttrium carbide.—Aberration and regression of the lymphatics in the course of development, by M. L. Ranvier. The growth of the lymphatics at the time of their formation is often so active that they appear in organs in which they have no functional significance, from which they have to be reabsorbed. Hence occasionally long vessels, closed at both ends, are found, corresponding to portions of the lymphatic system isolated by the atrophy of the intermediate parts. These small cysts may give rise to large cystic tumours.—On malformations of the hip, by M. Lannelongue.—Influence of vaccinal exanthema on microbial localisations, by M. S. Arloing.—Remarks on communication to M. Hermite, by M. Hugo Gyldén. A correction of a previous paper.—Observations of the comets. Perrine (1895, *c*), and Perrine-Lamp (1896, *a*), made with the large equatorial at the Observatory of Bordeaux, by M. L. Picart.—Observations of the sun, made at the Observatory of Lyons, during the last quarter of 1895, by M. J. Guillaume.—On asymptotic lines, by M. E. Goursat.—On the determination of the mass of the cubic decimetre of distilled water, free from air, and at its maximum density, by M. J. Macé de Lépinay. As the final result of a series of weighings in water of a quartz cube, the mass of a cubic decimetre of pure water at 4° C. is 0·999954 kilograms with a possible error of six units in the last figure.—*Rôle* of the different forms of energy in photography through opaque bodies, by M. R. Colson. The actions capable of affecting a sensitised plate are classified as mechanical, chemical, thermal, the infra-red rays, and the X-rays.—Electric effects of the Röntgen rays, by M. A. Righi. The X-rays are capable of producing the dispersion of electric charges upon dielectrics. By dusting a mixture of sulphur and red lead, or better, of talc and manganese peroxide over the plate of ebonite, images of interposed objects resembling photographs can be produced.—On some facts relative to the Röntgen rays, by MM. A. Battelli and A. Garbasso.—On some specimens of glass submitted to the action of the X-rays, by M. V. Chabaud.—On the Röntgen rays, by MM. C. Girard and F. Bordas. An experiment tending to show that the Röntgen rays proceed from both anode and kathode, and that the fluorescence produced on the walls of the Crookes' tube has only a slight effect upon a sensitive plate.—On the technique of photography by the X-rays, by MM. A. Imbert and H. Bertin-Sans.—Remarks added by M. d'Arsonval on the same.—On the centres of emission of the X-rays, by Prince B. Galitzine and M. de Karnojitzky.—On the direction of the X-rays, by M. A. Buguet.—Photography in colours; substitution of organic colours for reduced silver in photographic prints, by M. G. A. Richard.—Action of nitrogen peroxide and air upon the chloride of bismuth, by M. V. Thomas.—On the modifications of the grisometer and on the accuracy obtainable with it, by M. J. Coquillion.—On argon in the gas from the swimming bladder of fishes, by MM. T. Schlœsing, jun., and J. Richard.—Thermochemical study of the amides and ammonium salts of some chlorinated acids, by M. P. Rivals.—On the determination of the acidity of pyroligneous products, by M. Scheurer-Kestner.—On a new series of sulphophosphides, the thiophosphites, by M. Ferrand.—On some derivatives of triphenyl-silico-protane, by M. C. Combes.—On Russian essence of aniseed, by MM. G. Bouchardat and Tardy. This essence contains a large quantity of anethol, together with small quantities of anisic aldehyde, anisic acid, fenchone, and hydrocarbons of the composition $C_{15}H_{24}$.—On a case of lumbar *spina bifida*, by M. V. Ménard. —Influence of franklinisation upon menstruation, by M. E. Doumer.—Explanation of the flowers of the Fumariaceæ from their anatomy, by M. O. Lignier.—On an old schistous synclinal, forming the heart of Mount Blanc, by MM. J. Vallot and L. Duparc.—On the eruptive rocks of the Belledonne chain, by M. Louis Duparc.—On the mode of formation of the auriferous conglomerates, by M. A. Lodin.—Examination of the meteorite that fell at Madrid on February 10, 1896, by M. S. Meunier. The substance of the meteorite appears to be identical with the mineral chantonnite.—On mathematical synthesis, by M. L. Mirinny.—On a point in the kinetic theory of gases, by M. Chapel.—On photography through substances by electric currents, by M. Vaysse.—Remarks by M. Armagnac confirming the preceding.—On a probable cause of the explosion of meteors in the terrestrial atmosphere, by M. E. Hauser.

CONTENTS.

THURSDAY, MARCH 26, 1896.

THE SCIENTIFIC CORRESPONDENCE OF GEORGE ROMANES.

The Life and Letters of George John Romanes. Written and edited by his Wife. Pp. viii + 360. (London: Longmans, Green, and Co., 1896.)

THE life of most men of science is uneventful so far as the rest of the world is concerned, and can hardly interest more than the circle of personal friends. And the letters of men of science also have, as a rule, but a limited interest. Any scientific information which they contain has usually been published elsewhere, and if of importance, is already familiar to the scientific reader. The account of the life, and the selection of the letters of George Romanes, which is here presented, offer in some measure an exception to the general rule, for they contain matters which will keenly interest others than those who may desire to follow merely the scientific career of the man. But it is the scientific correspondence which will, without doubt, be that which will chiefly interest the readers of NATURE, and it is this, therefore, with which alone we propose here to deal. And of the scientific correspondence, that which Romanes carried on with Charles Darwin during a period of nine years would alone furnish enough interest to ensure a cordial welcome to this work. For Mrs. Romanes has not confined herself, as is so often done by the biographer, to presenting only the one side of a correspondence, but has wisely decided in this and certain other instances to allow both sides to appear, far more than doubling thereby its value and interest. And since, with one exception, none of these letters of Darwin have hitherto been given to the world, and moreover he seems in them to have opened up his heart with the frankest confidence to the young devotee whose powers of thought he was one of the first to recognise, it is obvious that this correspondence must have an altogether exceptional interest. It deals mainly, as might be supposed, with subjects bearing on the question of inheritance, and especially with Darwin's hypothesis of Pangenesis. In attempts to prove this theory, Romanes devoted an immense amount of time in patient experimentation, but as the experiments yielded for the most part a negative result, showing neither for nor against the hypothesis, they were never systematically published. On this account the descriptions of some of these experiments, which are here given at length, will be welcomed by those who may be carrying on similar work in the future. The subject was one upon which Romanes was "keen" to the very last, and almost the latest experiments which he planned, had a direct bearing upon the doctrine in question. And even when his time was fully occupied with the fascinating experiments upon Medusæ, by which he first found fame as a scientific inquirer, he was able to devote attention to the carrying out of laborious work on this subject. In July 1875, he writes to Darwin:

As you have heard about the Medusæ, I fear you will infer that they have diverted my attention from Pangenesis; but although it is true that they have consumed a great deal of time and energy, I have done my best to keep Pangenesis in the foreground.

Then follows a precise account of numerous experiments on grafting of tubers and the like, after which he continues—

But as I am a young man yet (he was just 27), and hope to do a good deal of "hammering," I shall not let Pangenesis alone until I feel that it does not admit of being any further driven home by experimental work; and even if I never get positive results, I shall always continue to believe in the theory.

And a little later—

I have an idea that you are afraid I am neglecting Pangenesis for Medusæ. If so, I should like to assure you that such is not the case. . . . I confess, however, that but for personal reasons I should have postponed Pangenesis, and worked the Medusæ right through in one year. There is a glitter about immediate results which is very alluring.

To which Darwin replies—

So far from thinking that you have neglected Pangenesis, I have been astonished and pleased that your splendid work on the jelly-fishes did not make you throw every other subject to the dogs.

In another letter from Darwin the following occurs—

As you are interested in Pangenesis, and will some day, I hope, convert an "airy nothing" into a substantial theory, therefore I send by this post an essay by Häckel, attacking "Pan.," and substituting a molecular hypothesis. If I understand his views rightly, he would say that with a bird which strengthened its wings by use, the formative protoplasm of the strengthened parts becomes changed, and its molecular vibrations consequently changed, and that their vibrations are transmitted throughout the whole frame of the bird. How he explains reversion to a remote ancestor I know not. Perhaps I have misunderstood him, though I have skimmed the whole with some care. He lays much stress on inheritance being a form of unconscious memory, but how far this is part of his molecular vibration I do not understand. His views make nothing clearer to me, but this may be my fault.

In a letter written in 1877, after referring in enthusiastic terms to a lecture by Romanes on the "Evidences of Organic Evolution," he says:

I am very sorry to hear about the failure in the graft experiments, and not from your own fault or ill-luck. Trollope, in one of his novels, gives us a maxim of constant use by a brick-maker, "It is dogged as does it!" and I have often and often thought this is the motto for every scientific worker.

With characteristic generosity Darwin handed over to Romanes, who was preparing his book on "Animal Intelligence," his notes on instinct.

You are quite welcome to have my longer chapter on instinct. It was abstracted for the Origin. I have never had time to work it up in a state fit for publication, and it is so much more interesting to observe than to write.

The book in question was heralded by a lecture on the subject given before the British Association at its meeting in Dublin in 1878. A copy of the lecture, as well as a newspaper account, from which it appeared that the lecture (especially an allusion in it to Darwin himself) was most cordially received, was sent by Romanes to Darwin, who thus acknowledges the receipt:

I am most heartily glad that your lecture (just received and read) has been so eminently successful. You have indeed passed a most magnificent eulogium on me, and I wonder that you were not afraid of hearing "Oh! oh!" or some other sign of disapprobation. Many persons think that what I have done in science has been much overrated, and I very often think so myself; but my comfort is that I have never consciously done anything to gain applause.

He jocularly adds in a short note sent a few days after—

Frank says you ought to keep an idiot, a deaf mute, a monkey, and a baby in your house.

To which Romanes rejoins—

Frank's idea of "a happy family" is a very good one; but I think my mother would begin to wish that my scientific inquiries had taken some other direction.

The baby too, I fear, would stand a poor chance of showing itself the fittest in the struggle for existence.

And two years afterwards the joke is continued (the baby having in the meantime put in an appearance).

I have now got a monkey. Sclater let me choose one from the Zoo, and it is a very intelligent, affectionate little animal. I wanted to keep it in the nursery for purposes of comparison, but the proposal met with so much opposition that I had to give way. I am afraid to suggest the idiot, lest I should be told to occupy the nursery myself.

The following postscript to a letter from Darwin, dated September 14, 1880, will be of interest.

We went to the Lakes for three weeks to Coniston, and the scenery gave me more pleasure than I thought my soul, or whatever remains of it, was capable of feeling. We saw Ruskin several times and he was uncommonly pleasant.

The postscript to another of Darwin's letters (dated January 24, 1881) is the following parable:—

N.B. Once on a time a fool said to himself that at an ancient period small soft crabs or other creatures stuck to certain fishes; these struggled violently, and in doing so discharged electricity, which annoyed the parasites, so that they often wriggled away. The fish was very glad, and some of its children gradually profited in a higher degree and in various ways by discharging more electricity and by not struggling. The fool who thought thus persuaded another fool to try an eel in Scotland, and lo and behold electricity was discharged when it struggled violently. He then placed in contact with the fish, or near it, a small medusa or other animal which he cleverly knew was sensitive to electricity, and when the eel struggled violently, the little animals in contact showed by their movements that they felt a slight shock. Ever afterwards men said that the two fools were not such big fools as they seemed to be.

About this time Romanes began to consult Darwin concerning experiments as to the relative effect of flashing and continuous light upon seedlings. These experiments were pursued at intervals during the next ten years, and the results were published in a paper read before the Royal Society in 1892. He tells also of a curious experiment on the sense of direction in cats.

I have got a lot of cats waiting for me at different houses round Wimbledon Common, and some day next week shall surprise our coachman by making a round of calls upon the cats, drive them several miles into the country, and then let them out of their respective bags. If any return, I shall try them again in other directions before finally trying the rotation experiment.

Not one cat, however, did return! Romanes used to describe with much amusement the ludicrous nature of the experiment as seen by passers-by.

Darwin was engaged just now (1881) upon his book on earthworms, and writes regarding it:

Your letter on intelligence was very useful to me, and I tore up and rewrote what I sent you. I have not attempted to define intelligence, but have quoted your remarks on experience, and have shown how far they apply to worms. It seems to me, that they must be said to work with some intelligence, anyhow, they are not guided by a blind instinct.

The following interesting remarks occur in the same letter:—

Dr. Roux has sent me a book just published by him, "Der Kampf der Theile," &c., 1881 (240 pages in length). He is manifestly a well-read physiologist and pathologist, and from his position a good anatomist. It is full of reasoning, and this in German is very difficult to me, so that I have only skimmed through each page, here and there reading with a little more care. As far as I can *imperfectly* judge, it is the most important book on evolution which has appeared for some time.

I do not know whether you will discuss in your book on the "Mind of Animals" any of the more complex and wonderful instincts. It is unsatisfactory work, as there can be no fossilised instincts, and the sole guide is their state in other members of the same order and mere probability. But if you do discuss any (and it will perhaps be expected of you), I should think that you could not select a better case than that of the sand-wasps, which paralyse their prey, as formerly described by Fabre in his wonderful paper in *Annales des Sciences*, and since amplified in his admirable "Souvenirs." Whilst reading this latter book, I speculated a little on the subject. Astonishing nonsense is often spoken of the sand-wasp's knowledge of anatomy. Now will any one say that the Gauchos on the plains of La Plata have such knowledge, yet I have often seen them prick a struggling and lassoed cow on the ground with unerring skill, which no mere anatomist could imitate. The pointed knife was infallibly driven in between the vertebræ by a single slight thrust. I presume that the art was first discovered by chance, and that each young Gaucho sees exactly how the others do it, and then with a very little practice learning the art. Now I suppose that the sand-wasps originally merely killed their prey by stinging them in many places (see p. 129 of Fabre, "Souvenirs," and p. 241), on the lower and softer side of the body, and that to sting a certain segment was found by far the most successful method, and was inherited, like the tendency of a bull-dog to pin the nose of a bull, or of a ferret to bite the cerebellum.

Darwin's attitude on the subject of vivisection is very manifest in several of the letters. As all the world knows, he did not himself practise vivisection, and the probability is that his gentle nature caused him to regard with more than ordinary dislike the necessity for experiments upon animals which might involve pain. But he saw so clearly that no real advance can be made in science without experiment, that he was ready even to come forward as a champion of the cause of physiology. In 1877, when the first antivivisection agitation was at its height, he writes:

I am inclined to think that writing against the bigots about vivisection is as hopeless as stemming a torrent with a reed. . . . It seems to me the Physiologists are now in the position of a persecuted religious sect, and they must grin and bear the persecution, however cruel and unjust, as well as they can.

And in 1881—

Do you read the *Times?* As I had a fair opportunity, I sent a letter to the *Times* on Vivisection, which is printed to-day. I thought it fair to bear my share of the abuse poured in so atrocious a manner on all physiologists.

Darwin's regard for physiologists was reciprocated; he and Sharpey were the first honorary members elected by the Physiological Society (of which Romanes was one of the first secretaries), a "mark of sympathy" with which he expresses himself as being "very much gratified." Needless to say Darwin's death was an untold loss to Romanes.

Even the death of my own father—though I loved him deeply, and though it was more sudden—did not leave a desolation so terrible. Half the interest of my life seems to have gone when I cannot look forward any more to his dear voice of welcome, or to the letters that were my greatest happiness. . . . And when I think how grand and generous his kindness was to me, grief is no word for my loss.

In the words of his biographer—"Thus closed a very significant and important chapter in his life."

Of Romanes' other scientific correspondence, the

earliest (1875-76) was with Prof. Schäfer, and related to his experiments upon Medusæ. In these letters he describes many interesting results which he was obtaining, and which were, for the most part, afterwards published in the *Philosophical Transactions*. He had then and always the pen of a ready writer (in hand as well as in tongue), and was besides in the habit of illustrating his descriptions by rough diagrams, so that they are admirably clear and instructive. Nearly all the other letters to scientific men are of comparatively recent date, and deal mainly with the controversies on problems of inheritance (physiological selection and Weismannism) in which, as the readers of NATURE well know, he was so deeply engaged. His paper on physiological selection[1] was read before the Linnean Society in May 1886. It raised a storm of opposition, largely, as he thought, because its opponents would not take the trouble to understand it. To Prof. Meldola he writes :

> Physiological selection seems to have brought a regular nest of hornets about my head. . . . It seems to me that there is a good deal of misunderstanding abroad, due, no doubt, to the insufficiency with which my theory has been stated.

There are also several long letters to Mr. Thiselton-Dyer and Mr. Francis Darwin on the same subject, and a friendly controversial correspondence with Prof. Poulton on the subject of Weismannism. But most of these letters have a more or less continuous thread of argument running through them, and do not lend themselves readily to extracts. The reader who is interested in the controversies is therefore referred to the originals. Even after he had been stricken by paralysis he was not to be deterred from continuing to discuss the problems which most interested him, and he carried on a long correspondence with the Rev. G. Henslow on the subject of the direct action of the environment on plant structures. In his last illness the personal sympathy which he received from his scientific friends much touched him, hard though he felt his fate to be. In a letter to Mr. Thiselton-Dyer, dated September 1893, he writes :

> When one is descending into the dark valley, scientific squabbles seem to fade away in those elementary principles of good will which bind mankind together. And I am glad to think that in all the large circle of my friends and correspondents there is no vestige of ill will in any quarter, unless it be with —— and ——, who both seem to me half-crazy in their enmity, and therefore not of much count.
>
> As for "fortitude," sooner or later the night must come for all of us ; and if my daylight is being suddenly eclipsed, there is only the more need to work while it lasts. But, to tell the truth, I do not on this account feel less keenly the pity of it. With five boys—the eldest not yet in his teens and the youngest still in his weeks ; with piles of note-books which nobody else can utilise, and heaps of experimental researches in project which nobody else is likely to undertake, I do bitterly feel that my lot is a hard one.

Throughout the letters the character of the man comes openly to the surface, and all the world may see in them the simple child-like nature, the unvarying good humour, the gentle disposition, which were combined in him with the highest intellectual attainments ; qualities which won for George Romanes the affectionate regard of all who were privileged to know him.

E. A. SCHÄFER.

[1] An admirable epitome of this theory (and of each one of the scientific subjects which chiefly engaged Romanes' attention) is given by his biographer in the book before us.

EARLY LEGENDS AND PREHISTORIC FOLK-LORE.

The Life and Exploits of Alexander the Great; being a Series of Translations of the Ethiopic Histories of Alexander by the Pseudo-Callisthenes and other Writers, with Introduction, &c. By E. A. Wallis Budge, Litt.D. Pp. xv + liv + 610. (London : C. J. Clay and Sons, 1896.)

WITHIN recent years it has been recognised that the legends and epics of ancient peoples are something more than collections of quaint and amusing tales, that they have a scientific value, and that they yield important results when studied, classified, and compared. The sagas of many nations are well known, and have been already subjected to an exhaustive process of inquiry, but those of others have still to be unearthed. Among this latter class the legendary literature of the Ethiopians had until recently to be set, but the volume by Dr. Wallis Budge, the title of which stands above, will go some way to remove the obscurity in which the beliefs and traditions of that nation have been shrouded. Hitherto the Ethiopic literature that has been published, has in the main been biblical and of interest chiefly to biblical students ; Dr. Budge, however, has collected a goodly body of Ethiopian traditions from MSS. in the British Museum and in the Bibliothèque Nationale, Paris, two of the former having been among those which were brought to England from the Treasury of King Theodore by the British Army in 1868. The Ethiopic texts of these MSS. have been edited by Dr. Budge, and they have been printed for private circulation by Lady Meux. An English translation and introduction which accompanied the text has, however, been published separately on smaller paper, for the use of those to whom the subject-matter, rather than the text of the MSS., would be of interest ; and it is with some of the results to be obtained from a perusal of this latter volume, that we propose in the present article to deal. It is not our purpose, however, to treat the legends from a literary point of view ; our object is rather to extract from them such information as will indicate what was the condition of geographical and astronomical knowledge among early Oriental nations, and to notice briefly the stories of heroes and others which grew up when the world was yet in its childhood, and when early man was himself still mystified by the phenomena of nature he beheld around him.

The central figure round which the stories group themselves is Alexander the Great, many of them being based on traditions or stories borrowed originally from other races. For instance, the book comprises the Ethiopic version of the Pseudo-Callisthenes, which has found its way into many languages ; extracts from the Ethiopic versions of larger historical works by Al-Makîn and Abû Shâker, Arabic historians of the thirteenth century ; and an extract from the Ethiopic version of Joseph ben-Gorion's "History of the Jews." The book also contains a short account of Alexander's death, and the utterances of the sages thereon ; the "Christian Romance," which is probably an original Ethiopian work ; and an account of the "Vision of Abbâ Gerasimus." None of the Ethiopic MSS. which contain these works is actually older than the seventeenth century ; they are, however,

copied from originals which must be put back many hundreds of years, and some of the legends that are inserted are of primeval antiquity.

Among all races, and especially in the East, the figure of some great national conqueror has always served as a centre around which floating legends and stories have gathered. An historical kernel no doubt underlies the mass, but it has been overlaid with numberless accretions, comprising some ancient legends to a certain extent the common property of all races, and others the special product of the race to which the writer belonged. Each nation that has retold the story of Alexander has modified and added to it to suit its own national ideals, so that the epic in its various forms comprises legends, the sources of which range from traditions of the ancient East down to those of mediæval Europe. Thus in the history of Alexander we find the ancient legends of Babylon have been laid under contribution. Alexander makes himself small, and flies through the air on the back of an eagle, exploring the heights of the heavens, "the beauties and the terrors thereof, and the stations of the birth and the going forth of the stars," in the same way as the Babylonian hero Etana flew to heaven with the eagle, who described to him the fashion and likeness of the earth as it seemed to recede from under them; and the same legend seems to be reproduced in another form in the "Christian Romance" (p. 474), when Alexander sends scouts from the Country of Darkness to the Country of the Living by making them ride on the backs of eagles. Alexander, too, is related to have travelled in the same regions, and to have met with the same adventures as the Babylonian hero Gilgamish; while his slaying of the dragon is clearly a reminiscence of the fight of the Babylonian god Merodach with the monster Tiâmat. As an instance of the way one of his Ethiopian biographers has incorporated material from contemporary sources, we may mention the story of the musical city (pp. 457 *ff.*) which Alexander at first cannot take, as his soldiers, after scaling the walls, are overcome by the beauty of the music produced by cunning contrivances of brass, to which figures of brass continually danced—a story which probably reflects some mechanical invention famous at the time of the writer.

The travels of Alexander furnish ample opportunities for the display of his biographers' knowledge or theories concerning geography and the extent and formation of the world. Thus, when travelling in the neighbourhood of Armenia, Alexander "came down to a very great mountain gate (*or* pass) wherein were many large roads by which merchants travel." Alexander makes inquiries, and he is informed by certain sages that the mountain only "ends at the sea that surroundeth the world, that is to say the sea Bôntôs (Pontus)," and this leads to a description of the far East and the nations who were said to dwell there. The same mountain, which was supposed to surround the world "like a ring," is referred to in another passage by the angel whose duty it is to hold it firm, and who describes it as "the father of all the mountains which are upon the earth," and adds that if plucked up by the roots the destruction of the earth would follow. Another curious geographical conceit occurs in an account of the origin of the Dead Sea, which is said to "stink horribly," because of the dead bodies of men and women and the carcases of beasts and birds which lie in its depths, whither they were brought by the waters of the Flood.

We gather, too, some interesting details concerning the ancient practice of magic and astrology. For instance, Aristotle is recounted to have presented to Alexander talismans to protect him against his foes, to enable him to enter fortified cities, for supplying him with water in the desert, and for protecting him and his army against fatigue. He also gave him certain amulets with somewhat similar powers, and furnished him with a device for destroying his enemies by means of waxen figures:

> "And Aristotle also made for Alexander a chest, and he placed therein figures which were made to represent his enemies, and they had leaden swords, which were curved backwards in their hands, and which they held downwards, and bows the strings of which had been cut; and he placed them in the box with their faces turned downwards, and he nailed them down with iron pegs and fastened the box with an iron chain."

Alexander had to keep the box carefully, and by laying his hand on it, and reciting certain prayers, he was assured of success against his foes. Aristotle is also credited with a knowledge of astrology, for he compiled for Alexander

> "a number of tables, that is to say, plans or drawings, wherein a star showed the time when he should go forth against his enemies . . . and he spake unto him, saying, 'Know, O King, that the stars are the head and foundation of the dispensation of this universe, and that it is by means of them that the world which is beneath the lowest heaven of the moon standeth. Know too that a certain section of the starry vault ruleth over each district and country on the earth. Now the portion that is over Persia hath therein the planet Mercury, and its regent is Venus, and its guardian is Jupiter, and its adversary is Saturn, and the star which hath dominion over it and worketh misery therein is the planet Mars, but the Sun keepeth it in safety, and the Moon giveth it strength and power. And each of these seven planets hath power over its fortune and over its days; therefore, O King, do thou direct thy course by the dispensation of the planets Saturn and Mars, and by the spiritual force which is in them, so that thou mayest be victorious over thine enemies thereby.'"

In the course of a review it is impossible to do more than briefly indicate the value of but a few of the legends and beliefs to be found throughout the 600 pages covered by the English translation. Reference, however, at least should be made to the stories of the magic stone, the fishes and the water of life, Alexander and his diving-bell, the monsters of the deep, Alexander's converse with beasts and birds, and the ride of Gerasimus upon the lion. The material here collected is, in fact, of great interest from many points of view, and not least from that of the student of folk-lore, who will find much useful information in the notes in which Dr. Budge has worked out the origin of many of the legends incorporated or referred to in the text. Our knowledge of ancient and mediæval science and superstition is gradually becoming more extended, and we venture to think that the volume before us will do much to help on the study. To summarise the universal character of the epic of Alexander, we cannot do better than quote Dr. Budge's own words:

"Given a brave, fearless soldier marching with an army through a certain country for conquest and pleasure, it seems that the same stories must be told of his progress and exploits, whether he be Etana, Gilgamish, Nimrod, or Alexander. With the advance of time the first tolerably accurate descriptions of his life will be first distorted and then enlarged, and when he has become a mere memory his name will be made a peg on which to hang stories, legends, and myths. The details of the fabulous history of such an one will be modified to suit the country and ideas of the people among whom the writers live, and eventually it will become the popular expression of the national views of each country through which the history passes of what a hero should be. This is exactly what has happened to the Alexander story in the hands of Semitic and other writers. The Egyptians made Alexander the son of an Egyptian king, and a worshipper of Amen; the Greeks made him the type of the victorious Greek conqueror; the Persians made him a Persian; the Arabs made him a servant of Allah; the Syrians made him a Christian; and the Ethiopians depicted him as a believer in the Trinity and in the Christian doctrine of the resurrection of the dead."

FISHES, LIVING AND FOSSIL.

Fishes, Living and Fossil: an Outline of their Forms and Probable Relationships. By Bashford Dean, Ph.D. Pp. xiv + 300. (New York and London: Macmillan and Co., 1895.)

DR. BASHFORD DEAN is known to zoologists, first, as the author of exhaustive and critical articles in the publications of the United States Fish Commission, on the systems of oyster culture pursued in Europe, and, secondly, as an embryologist who has lately been doing good work on the development of various Ganoid fishes and the comparison that may be instituted with Teleostei. His recent addition to the well-known "Columbia University Biological Series," now being brought out by Macmillan and Co., under the editorship of Prof. H. F. Osborn, is an interesting volume upon fishes, in which considerable prominence is given to the fossil forms, and the whole subject is presented to us from the point of view of the evolutionist. This is the characteristic feature of the book. From the very first page of the introduction to the last page in the volume, preceding the index, which is a table of the supposed descent of the groups of fishes, the book is full of the spirit and the language of evolution.

The fossil forms are introduced in their places amongst the living members of their group, and the plan of treatment of the groups in each chapter may be exemplified by No. vi., dealing with the Dipnoi, where we have first a short account of the lung-fishes, then the description of their structural characters, with an account of the fossil and of the living forms, and finally a discussion of their phylogeny and relationships with other groups. The figures in all parts are numerous and good, and many of them original.

The classification adopted is in the main that of Smith Woodward, in which the class Pisces excludes the Marsipobranchii (not that these are excluded from the book), and includes as sub-classes the Elasmobranchii, the Holocephali, the Dipnoi, and the Teleostomi. Our author considers then the Chimæroids as a distinct group equivalent to Elasmobranchii and Dipnoi, but adds: "The kinships of the Chimæroids seem unquestionably nearer the stem of the sharks than that of other fishes." He considers that the lung-fishes (Dipnoi) as a group "may not unreasonably be looked upon as descended from the primitive Elasmobranch stem." They are "an advancing phylum from which the amphibians may early have diverged." The remarkable fossil Arthrodira (*Coccosteus*, &c.), he follows Smith Woodward in considering provisionally as an order of extinct and highly-specialised lung fishes. A fine figure of the head of the giant predatory member of the group *Dinichthys intermedius*, one-tenth of the natural size, forms the frontispiece. These forms are now dissociated from *Pterichthys* and other lowly Ostracoderms, and also from the Siluroids, with which at various times they have been compared, and are united with the Dipnoi. The author believes, however, that the Arthrodirans may almost as well be referred to the sharks as to the lung-fishes, and that they may, perhaps, ultimately come to be regarded as worthy to rank as a distinct class. Dr. Dean builds his phylogeny largely on the solid basis of Palæontology.

After the systemic part of the book comes a chapter on development, in which, in addition to general remarks on eggs and breeding habits, a brief but adequate account is given of the embryonic and larval development of the five types—Lamprey, Shark, Lung-fish, Ganoid, and Teleost, with the view of contrasting the groups of fishes. This section includes a summary of Semon's observations on *Ceratodus*, and is illustrated by useful figures.

Throughout, structure is treated largely from the developmental point of view, which adds to the value, interest and freshness of the book. The author sums up against Gegenbaur's archipterygium, and in favour of the derivation of paired fins from lateral fin-folds. This view is supported by the simple condition of the pectoral and pelvic fins in the ancient fossil shark *Cladoselache*, the knowledge of whose archaic characters we owe to Dr. Dean himself. The vexed question of the precise function of the sense organs of the lateral line is still left undetermined. Beyond "feeling," in a broad sense, the author merely suggests "the sensory tracts along the sides of the body are certainly well situated to determine the direction of the approach of friend, enemy or prey." It is interesting—even if one can scarcely help feeling slightly disappointed—to read that: "It must for the present be concluded that the pineal structures of the true fishes do not tend to confirm the theory that the epiphysis of the ancestral vertebrates was connected with a median unpaired eye." He considers rather that the epiphysis was connected with the innervation of the sensory canals of the head.

At the end of the book we find a list of derivations of names, a good bibliography classified under groups and systems of organs, and, lastly, a series of tables giving in contrast form a statement of the comparative anatomy and embryology of the different groups of fishes, illustrated, like the rest of the work, by a series of clear figures drawn from the best sources, and many of them original. No doubt specialists on fossil fishes will be able to find defects and omissions, but for the ordinary student of the subject Bashford Dean's volume will prove useful and interesting.

W. A. H.

OUR BOOK SHELF.

British Moths. By J. W. Tutt. Pp. xii + 368. Illustrated. (London: George Routledge and Sons, 1896.)

THE last of the many recent additions, superficial and profound, to the stock of books on British Lepidoptera, is essentially a book for the beginner, but one which challenges consideration as an attempt "to deal with our moths on lines which the study of the last twenty-five years has convinced all true naturalists are the correct ones." The points by which this claim is redeemed consist mainly in the substitution of an arrangement based on Dr. Chapman's division of the Lepidoptera by pupal characters for the old order so long accepted, and by numerous statements of phylogenetic relationship. Supported as they are by very little in the way of explanation to make them intelligible, these innovations are not so much an improvement as a snare; it is of no use to talk glibly in a beginner's book about "Obtectæ and Incompletæ," "offshoots from a Pyralid stirps," and the like, unless these things are fully and clearly explained. Much of the phylogeny so confidently put forward is not that accepted by other recent writers on Lepidoptera and is unfit matter for dogmatic assertion, especially as first impressions thus acquired are hard to unlearn. Neither is the writer consistent, for the Hepialidæ, Micropterygidæ, and Eriocephalidæ are separated from each other by numerous families, although the position, remote from all other Lepidoptera, that has been assigned to the three is one of the most important and widely-accepted of recent changes. Turning to those parts of the book which have no special claim to novelty of treatment, we find, as is to be expected from so competent a lepidopterist, that his statements are accurate and often valuable. But far too much space is taken up, particularly in the Noctuæ, with brief remarks on species which convey no real information. In spite of another claim put forward in the preface, it is only here and there that a species is described in recognisable terms. If all perfunctory mention of species had been excluded, and the work confined, as a book of limited scope may well be, to such moths only as are common and of wide distribution, space could have been gained for an adequately-full treatment of the species retained. The coloured illustrations are fairly good; there is but one diagram of neuration, and that is incorrect. W. F. H. B.

Moorland Idylls. By Grant Allen. Pp. 257. (London: Chatto and Windus, 1896.)

By Tangled Paths. By H. Mead Briggs. Pp. 203. (London: Frederick Warne and Co, 1896.)

THE descriptions of scenes of pastoral life contained in the first of these volumes have, we believe, already appeared in one of the monthly magazines, though no reference is made to that fact. They may be regarded as science diluted with sentiment, and that is the kind of literature which the average man and woman will sometimes read. Nevertheless, if Mr. Allen's idylls lead people to observe and think about the habits and characteristics of common plants and animals, they will accomplish a useful purpose. The sympathetic spirit in which they are written will attract lovers of nature, and will do much to foster a feeling for the preservation of our native fauna.

Mr. Briggs's dainty volume is much the same in character as that of Mr. Grant Allen's, the chief differences being that it is a little more poetical, and a little less instructive. The contents furnish suitable reading for persons who muse over the poetry of nature; and judging from the abundance of literature of a similar character, there must be many who like to engage their minds on natural things.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Sun Columns at Night.

A REMARKABLE phenomenon, similar to that which I described in 1888 (NATURE, vol. xxxviii. p. 414), was witnessed by me on the evening of March 13. At 7h. 7m. p.m. I saw on the western sky five silvery white columns coming evidently from the sun, which set at 6h. 1m. The columns extended over the whole sky, and, like meridians on a globe, converged to a point in the eastern sky, which was about as high above the eastern horizon as the sun was below the western horizon. The sky was full of stars, a powerful wind having swept it clear; and at 7h. 25m., fifteen minutes before complete night had set in, the rays still reached the zenith. The rays cannot be *straight* sun rays, for the calculation of the height of the atmosphere by Alhazen's method would yield an abnormally high value, and they could not meet in the east, like meridians, but they must be *curved* and pass *along* the upper strata of the atmosphere. This is either due to reflection, or, more probably, the phenomenon is one of an electrical nature, similar to that described in NATURE of March 12 (p. 437), which has just reached me, by Dr. O'Reilly.

The remarkable fact that at 7h. 25m., when the sun was about 14° below the horizon, the perpendicular arc reached the zenith, whereas that passing along the equator extended to about Cancer, appears to prove that the equatorial diameter of the atmosphere greatly exceeds the polar diameter. The phenomenon disappeared at 7h. 28m. BOHUSLAV BRAUNER.

Bohemian University, Prague, March 16.

Kathode Rays or X-Rays?

TO the reader of the numerous papers that have recently been communicated from various sources on the subject of Dr. Röntgen's great discovery, considerable obscurity is caused by the confusion of the above terms. Until quite recently what has been meant by "kathode rays" or "the kathodic discharge" has been that discharge of matter from the negative electrode in a highly-exhausted vacuum tube, which can be deflected by a magnet, produce heat, mechanical energy, and phosphorescence, can be brought to a focus by using a curved kathode, and in this case will project an inverted image of the kathode upon either the inside walls of the tube, or upon a phosphorescent screen placed inside the tube to receive it. As is well known, this discharge has been very thoroughly investigated abroad by Hittorf, Puluj, and others, and in England by Crookes, and has been called by him the discharge of "radiant matter." The X-rays of Dr. Röntgen are said to be generated at the spot where the kathodic discharge of radiant matter impinges upon an obstacle, be it the phosphorescent walls of the vacuum tube, or a plate of metal similarly placed to receive it. The distinction is perfectly clear in Dr. Röntgen's paper, as the following extracts from the translation, published in this journal on January 23, show.

"In general, other bodies behave like air; they are more transparent for the X-rays than for the kathode rays. A further distinction, and a noteworthy one, results from the action of a magnet. I have not succeeded in observing any deviation of the X-rays even in very strong magnetic fields. The deviation of kathode rays by the magnet is one of their peculiar characteristics."

"Hence I conclude that the X-rays are not identical with the kathode rays, but are produced from the kathode rays at the glass surface of the tube."

"I have obtained them in an apparatus closed by an aluminium plate 2 mm. thick."

It will therefore surely be better to retain the term proposed by their discoverer, X-rays, or else to call them Röntgen rays, and thus avoid the confusion that must result from calling them "kathode rays." JAMES H. GARDINER.

A Remarkable Meteor.

THE slow-moving meteor of March 1, 8h. 31m., described by Mr. J. E. Clark at York (NATURE, March 12, p. 437), was observed by Mr. T. W. Backhouse at Sunderland, and he noted

the path as from $\beta - \alpha$ Canis Minoris eastwards passing $170° \pm 0°$ and disappearing behind a cloud about $5°$ beyond the latter point. The duration was $6\frac{1}{2}$ seconds.

Comparing the two observations, I find the radiant was in Pisces at $18° + 5°$, which at the time of the meteor's appearance had an altitude of about $4°$ only in due west. The meteor was first seen from Sunderland when it was over a point near York at a height of 59 miles, and when last seen from York it was over Heligoland at a height of 49 miles. The Sunderland observer noticed the meteor a little earlier in its flight than the observer at York; while at the latter place it was retained much longer in view than at Sunderland, where a cloud appears to have obscured the terminal stages of the phenomenon. The whole length of its path was about 370 miles; Mr. Backhouse, at Sunderland, watched the meteor traverse 195 miles, so that his estimate of the duration would give 30 miles per second for the velocity. Mr. Clark saw 338 miles of the path, and his estimate of 32 seconds would give $10\frac{1}{2}$ miles per second. The difference may be partly accounted for on the supposition that owing to the resistance of the atmosphere the meteor slackened considerably in speed during the latter part of the flight.

When last seen by Mr. Clark, the meteor was close to its anti-radiant and travelling in a nearly direct line away from the observer, so that its apparent motion would be very very slow, and the object must have looked like a hazy almost motionless star near the eastern horizon.

The radiant point at $18° + 5°$ in Pisces indicates a place in the heavens where no meteor shower has ever been observed in the first quarter of the year—in fact, on March 1 it is only $35°$ east of the sun. In the summer and autumn, when the constellation Pisces is favourably presented in the dark sky, many meteor showers radiate from it and some brilliant fireballs have been directed from a similar position. The following instances may be noted:—

	° °		
1884 Aug. 25	... $10 + 5\frac{1}{2}$	... Fireball	... Niessl
1858 Aug. 26	... $11 + 0$	... ,,	... ,,
1868 Sept. 5	... $14 - 2$	... ,,	... ,,
Sept 3-10	... $17 + 9$	... Meteor shower	... Schmidt
1877 Sept. 12	... 10 ± 0	... ,,	... Denning
1885 Sept. 15	... $13 + 6$	... ,,	... ,,
1875 Sept. 24	... $2 + 2$	... Fireball	... Herschel
1864 Sept. 27	... $12 - 2$	... Meteor shower	... ,,
1891 Sept. 30	... $14 + 7$	... Fireball	... Denning
1887 Oct. 11	... $13 + 6$	... Meteor shower	... ,,
1876 Oct. 19-21	... $11 + 8$	... ,,	... ,,
1872 Oct. 30	... $14 + 7$	... ,,	... Backhouse
Nov. 11-14	... $10 + 5$	... ,,	... Heis

The mean position seems to be about $13° + 5°$. It declines so far to the west in November that no showers have been seen from it afterwards, though it occasionally yields fine slow-moving fireballs. Thus in 1891 Dec. 20, 8h. 38m., I saw a meteor, equal to Venus, moving very slowly from $124° + 64°$ to $159° + 49°$, and presumably from this radiant in Pisces.

Bristol, March 19. W. F. DENNING.

Barisal Guns.

IN regard to the "barisal guns" or "mist pouffers," lately described in NATURE, similar sounds have been heard in this region.

On July 4, 1808, the expedition of Captains Lewis and Clark was at this place. Under that date we find the following entry in their journal: "Since our arrival at the Falls we have repeatedly heard a strange noise coming from the mountains in a direction a little to the north of west. It is heard at different periods of the day and night, sometimes when the air is perfectly still and without a cloud, and consists of one stroke only, or five or six discharges in quick succession. It is loud, and resembles precisely the sound of a six pound piece of ordnance at the distance of three miles. The Minnatarees frequently mentioned this noise like thunder, which they said the mountains made, but we paid no attention to it, believing it to be some superstition or falsehood perhaps. The watermen also of the party say that the Pawnees and Recaras give the same account of a noise heard in the Black Mountains [Black Hills] to the west of them."

The mountains towards which these noises were heard were the main range of the Rockies, and distant about eighty miles. In 1854, Mr. Doty, of Governor Stevens's party, heard similar noises. He was near enough to the mountains to be certain that the noises came from them. The locality where Mr. Doty heard them was where the direction observed by Lewis and Clark would strike the mountains.

Plenty of white men have been in this country for the last thirty years, or since 1866. I have made careful inquiry among pioneers, but cannot learn that the noises have been heard since Mr. Doty's report.

In 1810 a party, outfitted by John Jacob Astor, made an overland trip from the Missouri to the mouth of the Columbia. They tried to go through the Black Hills, but were obliged to withdraw and flank them. In these hills they note as follows: "In the most calm and serene weather, and at all times of the day or night, successive reports are now and then heard among these mountains, resembling the discharge of several pieces of artillery. Similar reports were heard by Messrs. Lewis and Clark in the Rocky Mountains.

Such explosions are also said to occur frequently in Brazil. "Vasconcellis, a Jesuit father, describes one which he heard in the Sierra, or mountain region of Peratininga, and which he compares to a park of artillery." CHAS. H. ROBINSON.

Great Falls, Montana, March 5.

Ostwald's Energetics.

IT may not perhaps be irrelevant to point out that even were it permissible to assert—as Prof. Fitzgerald conclusively shows that it is *not*—that because certain natural processes do not under actual conditions reverse, therefore they are irreversible, the examples of irreversibility in nature, on which Prof. Ostwald founds his "fourth attack" on the mechanical theory, are singularly ill-chosen. He directs us to the life-histories of organisms, these life-histories themselves being but a very brief portion of the indefinitely long series of transformations which the matter for that short time identified with them is going through. Yet even within this narrow range reversible actions are to be found. Surely all metabolic processes must be regarded as such. Moreover at this very moment there may quite possibly be built into our own bodily tissues, matter which some generations ago entered into the physical composition of our ancestors, has since been degraded from the rank of organic substances altogether, and is now through new-old combinations and re-combinations once more raised to its former position and forms part of a living organism. If this can come to pass, vital phenomena are clearly not irreversible. It may take much more than the lifetime of a man or of a tree for the whole cycle of operations to be complete; but when it is complete, we have as fair an example of a reversible series as we are likely to find in nature. E. M. C.

"E. M. C." calls attention to the fact that if trees do not grow into seeds they do grow seeds. This and other cases of reproduction are no doubt cases of *reproducing* the original condition, but Prof. Ostwald would rightly refuse to recognise them as cases of *reversion* to the original condition in the dynamical sense. In the case of a dynamical reversal the flow of energy is reversed. In order to have a case the reverse of the growth of a tree, it would be necessary to have a tree which radiated heat back to the sun in the reverse direction to the flow which at present takes place from the sun to the tree. Otherwise Prof. Ostwald would rightly deny that it was a genuine case of dynamical reversion. It was on account of this complication involved in Prof. Ostwald's example that I cited the very much more simple cases of irreversible thermodynamic operations, such as friction and flow of heat from hot to cold. To cite the very complex organic cases of irreversible operations instead of the simple ones, is only to cloud the question with complexity.

Prof. Boltzmann has already devoted himself to combat Prof. Ostwald's Energetics, and it would be well for those who feel any leaning towards the latter to study the views of this father of the kinetic theory of gases. GEO. FRAS. FITZGERALD.

Trinity College, Dublin, March 18.

Classifying Crushed Ore by Trommels.

IT was very pleasing to me to read in your valuable publication of November 7, 1895, the favourable criticism written by your correspondent, Mr. T. K. Rose, on my report on the loss of gold in the reduction of auriferous veinstone in Victoria. Nevertheless, permit me to make a few remarks to endeavour to

remove a misapprehension under which, it seems to me, that he was labouring, after perusing my report, with regard to the limit to which I suggest volumetric sizing. He seems to think I advocate that the grading of the sand, which has been separated, as far as feasible, from the slimes (which are to be subsequently classified separately in four Spitz-Kästen), should be effected through very fine sieves—60-mesh screens, or under. I quite agree that to attempt to do so would fail. Such, however, is not the meaning, or, I think, the construction which can be placed on the context of my report. A glance at the diagram illustrating the sequence of the methods of reduction, clearly shows, I submit, that it is only the *coarser sands issuing from the bottom of the slime separator*, that are subjected to "volumetric sizing" in a trommel, which classifies them into three grades, the finest being through a 40-mesh sieve, which is, I apprehend, practically, the most suitable grade for the Frue-vanners to do close work; the overflow from the concentrates flowing into the Spitz-Kästen.

I trust that these observations will dispel the misapprehension which your correspondent entertained on this point at the time when he wrote his article, as I respect his opinion, and would regret to be misunderstood by him. HENRY ROSALES.

I REGRET to have misunderstood Mr. Rosales, whose report is certainly entitled to most respectful and careful consideration. My mistake (a natural one, I think) arose from a statement made on p. 13 of the report. Here Mr. Rosales says, in speaking of the Johnson's Reef Gold Mines Company, Eaglehawk, that "the battery sand should previously be classified into different grades by 'sizing'. . . . Such could be accomplished by delivering it into trommels fitted with screens of different meshes. The mantel of the first trommel might be a sieve of 40 to 50 holes to the lineal inch, and the second trommel might be covered with *a screen of* 64 *holes to the lineal inch*. . . . This system of sizing would certainly be applicable." (The italics are my own.) On p. 50, where Mr. Rosales recurs to the subject of trommels, he does not mention any screen finer than 40-mesh, but, on the other hand, does not state that this is the finest that should be used, and refers to it merely in the following words:—"Supposing it [*i.e.* the trommel] to be covered with $\frac{1}{30}$ or $\frac{1}{40}$ wire gauze." Mr. Rosales' explanation will, I feel sure, be gladly received by others, besides myself, who have read his valuable report.

T. K. ROSE.

Crush-Conglomerates in Ireland.

IN your issue of March 5 there is a letter from Mr. McHenry, in which he mentions the occurrence at Portraine and Lambay Islands, Co. Dublin, of conglomerates which he considers to be of the nature of crush-conglomerates. During the past two summers we have been examining these sections, and can corroborate Mr. McHenry's statements with regard to the presence of crush-conglomerates; but our investigations have not led us to conclusions altogether similar to his, with regard to the igneous rocks of the district. We hope to publish our results before very long.

S. H. REYNOLDS.
C. I. GARDINER.

CLAUDIUS PTOLEMY AND HIS WORKS.

CLAUDIUS PTOLEMY! What reader of the most elementary science is not familiar with his name, at least in adjectival form, in connection with the Ptolemaic system, and yet how little is known of him as a personality. That he lived in Egypt during the reigns of Hadrian and Antoninus Pius, and made astronomical observations chiefly on a terrace in Alexandria, sums up nearly the whole. But his works (addressed to Syrus, of whom also nothing is known) were the standards of authority in geography and astronomy for many centuries after his death; and though the tide of science has left them far behind, they can never be quite forgotten or cease to be of high interest in scientific history. His great astronomical work was translated into Arabic (changing its name in the process), and on the revival of learning in Europe was translated from that language into Latin, as it afterwards was from the original Greek. A French version was published by Halma at Paris in 1813–16, but no English rendering (except of small portions) has ever appeared. The British Museum Catalogue shows that our national collection contains a large number of Greek editions and Latin translations of the Almagest (as the Μαθηματικὴ Σύνταξις is always called, from the Greek for "greatest," with the Arabic definite article prefixed) and Geography of Ptolemy, as well as of most of his smaller works; Halma's editions of the Greek of the Almagest and Geography, with French translation in parallel columns; and Italian translations of the latter and of the Optics. Every student of Ptolemy must be under so much obligation to Halma, that it may be of interest to state that he was born at Sédan in 1755, and after being Principal of the college of his native town, became Professor of Mathematics at the Prytanée at Paris, where he held at various times other offices, one of them being that of librarian to the Empress Josephine. Besides his version of Ptolemy and of the not very lucid Commentary of Theon (father of the ill-fated Hypatia) on part of the Almagest, he published a French translation of the Phenomena of Aratus, and died in 1828. His edition of the Almagest is preceded by an elaborate and interesting preface, and has appended to it some Notes by Delambre. Two of Ptolemy's minor works, the Planisphærium and the De Speculis, appear to be extant only in Latin versions; the chronological table, however, of reigns up to his own time still exists in the original, whilst of the astrological work called "Tetrabiblos" or "Quadripartitum," we have not only the Greek, but Latin, French, and English translations.

The Almagest was so exhaustively examined and commented on by Delambre, that little can be added to his conclusions.[1] It is evident that Ptolemy's work is founded chiefly upon the observations of Hipparchus, which were made at Rhodes about three centuries before. Lord Macaulay's omniscient schoolboy probably believed that Ptolemy founded the system by which sun, moon, planets, and stars all moved round the earth, though the thought may have crossed his mind that this view was held before the appearance of the Alexandrian astronomer. This is, in fact, somewhat akin to the extensively-believed idea that Newton discovered the fact that external bodies are drawn or attracted to the earth. What is really due to Ptolemy as the author of the Ptolemaic system, is the reducing into a systematic form for explaining the planetary motions the ingenious imaginative machinery of epicycles and deferents. This is now so generally understood that we need not enlarge upon it here. It is almost remarkable that his discussion of the motions of the inferior planets, Mercury and Venus, did not lead him to the elaboration of the Tychonic system, something akin to which Vitruvius and Pliny seem to have had in mind, and which would in that case have held its ground for centuries; when actually started by the Danish astronomer, it was behind the age and soon stranded by the advance of science, his own contemporaries seeing that its cause was hopeless from the first. More credit is due to Ptolemy for his investigations respecting the motions of the moon, which led him to the discovery of the inequality known as the lunar evection. The inequalities he endeavoured to explain by epicycles, but for the latter he introduced in addition an eccentric, the centre of which turned about the earth in a direction contrary to that of the motion of the epicycle. A not inconsiderable portion of the Almagest is devoted to eclipses and their prediction; and we are indebted to Ptolemy for an account of three eclipses of the moon which were observed at Babylon in the years B.C. 721 and 720 under a king whom he called Mardokempados, but whose real name was Merodach-Baladan, and who, after a long contest, was completely crushed and de-

[1] A very able though shorter discussion is given in Narrien's "Historical Account of the Origin and Progress of Astronomy."

prived of his dominions by Sargon, the greatest of the Assyrian monarchs.

Ptolemy describes his method of attempting to determine the distances of the moon and of the sun. To the former he obtained a very fair approximation, making it equal to about fifty-nine semidiameters of the earth; but the sun's distance he thought to be only about 1210 of these semidiameters, or about twenty times the distance of the moon, which is in that unit only about the square root of its true amount. The eighth book of the Almagest contains the earliest extant catalogue of stars, founded upon that of Hipparchus. Six stars are marked red or reddish, one of which, Sirius, has ceased to be so, furnishing a remarkable instance of change of colour; the reading in Ptolemy was contested, but there is no real reason (as has been pointed out by Dr. See) to doubt its genuineness, and the red colour of Sirius in ancient times is confirmed by the testimony of several classical writers.

We must now turn from Ptolemy as an astronomer to Ptolemy as a geographer. If his work in the former department is founded principally upon that of Hipparchus, so does he take for the basis of his geographical system the work of Marinus the Tyrian, which in its latest form but little preceded his own. Those only who are ignorant of both can accuse Ptolemy of plagiarism in this, seeing how fully he recognises his obligations to his predecessor whilst pointing out the necessity of modifying some of his conclusions with regard to the most distant known regions of the world. But for Ptolemy, indeed, we, in these days, should never have heard of Marinus at all. "It is clear," says the late Sir E. H. Bunbury, "that he did not attempt to present his readers with a complete body of descriptive geography such as was furnished by the comprehensive work of Strabo. His object, like that of Eratosthenes at an earlier period, was simply to correct and reform the map of the world so as to adapt it both to the increased knowledge of distant countries and to the improved state of mathematical science, which were possessed in his day." Much more was then known than in the time of preceding geographers of the extent of Africa towards the south and of Asia towards the east; but, in applying this increased knowledge, Marinus exaggerated the extensions so greatly as to distort his map of the world almost as much as theirs, though in the opposite way. This led him to what was, to some extent, a retrograde step—the idea that Asia had an indefinite extension towards the east, similar to that entertained by Columbus when he expected to reach the Indies by a voyage to the west, little dreaming of another isolated continent between.

Ptolemy refers to his astronomical in his geographical work, so that the latter must have been composed subsequently to the former, and its date was probably near the end of the reign of Antoninus Pius, who died in A.D. 161. He fully appreciated the necessity, if positions in the world were to be accurately laid down, of determining their latitudes and longitudes and mapping them thereby. But, unfortunately, in his time the number of places for which this had been done was so small that he was obliged, to a very great extent, to rely upon results obtained from itineraries by the old rough method. These he places before us, both on his map and in extensive tables, as if they had been really founded upon scientific determinations. To quote Bunbury again: "He saw clearly the true principles upon which geography should be based, and the true mode in which a map should be constructed. But the means at his command did not enable him to carry his ideas into execution; the substance did not correspond to the form, and the specious edifice that he reared served, by its external symmetry, to conceal the imperfect character of its foundations and the rottenness of its materials." Some of the exaggerated conclusions of Marinus, particularly with reference to the distances of places in the east of Asia, he rejects, but can only suggest conjectural reductions of them. But even in lands within the bounds of the Roman Empire, few indeed were the places of which even the latitudes, still less the longitudes, had been scientifically determined. Hipparchus had suggested the observation of lunar eclipses at different stations as a means of finding the difference of longitude of these stations; but even in the time of Ptolemy, no such determinations had been actually made, though he refers to one which took place on September 20, B.C. 331, shortly before the battle of Arbela, or rather Gaugamela, which was observed, but not with sufficient accuracy to make it the basis of calculation. In inquiries of this nature, a remark made by the late Sir George Airy often comes into one's mind: "The first man who made good astronomical observations was the first man who made good clocks"—a graphic way of saying how essential was an accurate means of measuring time.

We have reserved but a short space to speak of what may be called Ptolemy's minor works. The principal of these are his Tetrabiblos or Quadripartite, which is in fact a treatise on astrology in the modern sense of the word, and his Harmonics, in which he gives an account of the theory of music. The former (as well as the Centiloquy, or hundred aphorisms, which forms a sort of supplement or summary to it) has been translated into English, the last time by J. M. Ashmand, whose version was published in 1822, and dedicated (like the Prince Regent's famous bumper in Scott's presence) to the author of Waverley. There does not appear any good ground for doubting its genuineness, though many have wished to do so from their admiration of Ptolemy, and feeling that it was unworthy of him. Great astronomers, however, in later times than that of Ptolemy, have believed in the delusive and imaginary "science" of judicial astrology, which still serves to charm some of the ignorant and foolish, and excite apprehensions in others of that still large family. The translator of the Tetrabiblos (who appeared before the public only in that capacity) had no feeling of this kind, and endeavours in a note to parry an objection to astrological predictions as old as the time of Cicero by citing a case of a man who, he tells us, was born within a few moments of George III., and in the same parish, went into business in the same month (October 1760) in which that king came to the throne, was married, like him, on September 8, 1761, and died, like him, on January 29, 1820, "coincidences," we are told, "highly remarkable." However, if any one can derive amusement from astrology, we need not object. Flamsteed drew the horoscope of the Royal Observatory, Greenwich, at the moment of its foundation, though he affixed a line from Horace asking who could forbear laughter. So we may take a few of Ptolemy's notions, one of which was that natural characteristics in different regions and climates was caused by the planets and constellations holding sway there, whence the inhabitants of Britain, for instance (and let us remember that by the argument this still applies), are, he tells us, wilder, bolder, and more ferocious than others.

Ptolemy's Harmonics was edited, with a Latin translation, by Dr. Wallis, in 1682, and an abstract of it is given in Rees's Cyclopædia. We cannot describe here his proposals for the reformation of the musical scale; but we cannot help regretting to find him, in the third book, going off into fanciful musical relations amongst the celestial spheres in a way which reminds us of some portions of his book on astrology.

Our author wrote a work on Optics, which is only known to us through Latin versions made from incomplete Arabic manuscripts. He is said to have discovered the fact of the refraction of the rays of light by passing through substances of different density; but, like

Descartes with regard to the law of this refraction, he was probably anticipated, and by a much longer interval. His Planisphere and other smaller works scarcely call for notice. On the whole, it may be said that Ptolemy was rather a collector and condenser of the scientific facts and methods than an original discoverer or investigator. And with all proper Baconian admiration for the wisdom of the ancients, we may be thankful that in our time, at least in the domain of natural science, the wisdom of the moderns has been added to it.

W. T. LYNN.

A VIEW OF KILAUEA.

THE interest of Kilauea is perennial. Popocatapetls may arise in a night, or Krakatoas may be blown to shivers, and attention may thus be temporarily withdrawn from the great Hawaiian volcano. But such cataclysms are exceptional. Kilauea, on the other hand, is always available to the student of vulcanicity, while Dutton's beautifully illustrated memoir, and Dana's great monograph enable observers to use their opportunities to the fullest advantage. Dr. Benedict Friedlaender's papers in *Himmel und Erde* (Bd. viii. 1895) are the latest addition to the extensive literature upon this subject, and give a series of photographs, which are a useful supplement to those of the two American authors. Dr. Friedlaender's narrative shows that the mountain can now be studied without inconvenience. A good track runs from Kilo, on the north-eastern coast of Hawaii, to the summit of Kilauea. It passes first through plantations of sugar-cane and banana, and past clumps of screw-pine (*Pandanus*). At the height of about 1000 metres the tropical vegetation is left behind; trailing Freycinetias and great Cibotias give place to tree ferns and an undergrowth of plants of temperate affinities, such as cranberries (*Vaccinium*). On the north-eastern edge of the crater, at the height of 1230 metres, is a good hotel, in telephonic communication with the coast. Dr. Friedlaender's description of the mountain takes us over a good deal of old ground; but his account records recent changes, and his notes and views bring out several characteristic features of the volcano. In the first place he emphasises the fact that though Mauna Loa rises to the height of the Jungfrau, neither it nor Kilauea have any claim to be called mountains. Whereas some of the Italian volcanoes have slopes of 30°, that of Mauna Loa is only 6°, and that from the summit of Kilauea to the north-east cape of the island is only 1° 35′. The summits of the volcanoes are not mountain summits, but only a high plain. Orographically, Kilauea is only a lateral crater on Mauna Loa; but geologically they must be regarded as two distinct volcanoes, as eruptions sometimes take place on Mauna Loa, while the lava lake in the other is at rest. As Mauna Loa is 3000 metres higher than Kilauea, and the weight of a column of basaltic lava of that length is 900 atmospheres, this independence of the two volcanic centres appears at first sight to be in contradiction to the fundamental principles of hydrostatics. The author explains this by the assumption, that the lavas in the central pipe of Mauna Loa are of lower specific gravity than those of Kilauea, owing to the greater abundance of

The lava lake.

(a)
(b)
(c)

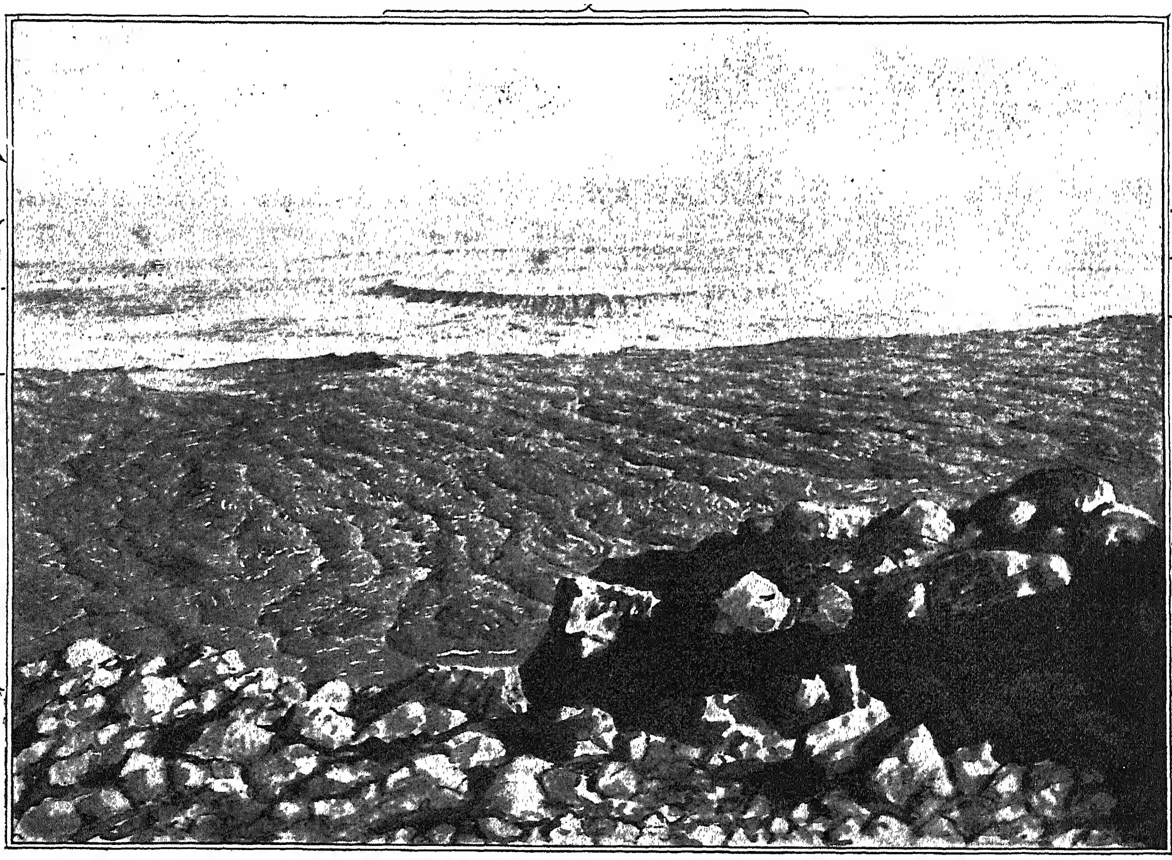


FIG. 1.—(*a*) Hut. (*b*) Margins of the secondary crater. (*c*) Margins of the primary crater. (*d*) Secondary crater. (*e*) Primary crater.

gas in them. The insignificant action of steam in Kilauea is declared by the author to be the most remarkable fact about it; for he says that it works "practically without steam, but with colossal quantities of highly fluid lava." Hence explosive action is very exceptional, though such an eruption did once occur in that year of violent upheavals 1789. It is owing to Kilauea having been built by the slow, quiet, piling up of lavas without explosions, that its crater is so very different from that of the Italian volcanoes. Instead of a narrow, deep, gullet, it is a broad, open, cauldron-shaped depression. The accompanying view illustrates the nature of the crater; it is from a photograph taken from the north-western corner, and looks due southward. In the foreground are some blocks of lava, on the margin of the plateau in which the crater lies; beyond this is the flat floor of the primary or major crater, at the foot of a vertical lava wall, 140 metres in height. The greatest diameter of the major crater is 4·7 kilometres; but the width to the opposite wall, seen in the figure as a long, low line in the far distance, is at this point only a little over 3 kilometres. In the centre of the view is seen the famous lava lake, 250 metres in diameter; this occurs in a raised tertiary crater in the centre of the depressed secondary crater. This latter extends across the view from side to side, but it is small in comparison with the primary crater; its average diameter is only 700 metres, so that its area is only about half a square kilometre, whereas the major crater occupies 10·6 square kilometres. The depth of the secondary crater is about 20 metres.

Dr. Friedlaender remarks that in addition to the subjective difficulty in the description of a volcano, there is, also with Kilauea, the objective difficulty of the rapid changes that take place there. These render necessary frequent periodical re-descriptions. One such change is now in progress, for after a pause of fifteen months the mountain is again in active eruption.

NOTES.

THE British Section of the International Memorial to Pasteur has now assumed definite shape, and the Provisional Committee, which already includes the names of the Dukes of Devonshire and Westminster, and many distinguished men of science from all parts of the United Kingdom, held its first meeting last Friday, at the rooms of the Royal Society, Burlington House, under the presidency of Sir Joseph Lister. It was unanimously decided to apply for subscriptions towards the erection of a monument to Pasteur in Paris, from persons in the United Kingdom, India and the Colonies, interested in science and the various industries which have been benefited by Pasteur's labours. An Executive Committee was formed, consisting of Sir Joseph Lister, Sir John Evans, Sir Henry Roscoe, Dr. Thorne Thorne, and Prof. Percy Frankland (Hon. Secretary). Subscriptions may be sent to Sir John Evans, who will act as Hon. Treasurer, at the Royal Society, Burlington House, W.

AT the stated meeting of the Royal Irish Academy, held on March 16, the Earl of Rosse, K.P., F.R.S., was elected President, in succession to Dr. J. Kells Ingram, whose term of office had expired. The President nominated as Vice-Presidents—The Rev. Dr. Haughton, F.R.S., the Most Rev. Bishop Donnelly, D.D., Dr. J. Kells Ingram, and Dr. Ben. Williamson, F.R.S. The following were elected Honorary Members in the Department of Science—Sir Joseph Lister, Bart., P.R.S., Sir W. H. Flower, K.C.B., Rev. T. G. Bonney, F.R.S., and Prof. Wm. Ramsay, F.R.S.

IN the Japanese Imperial Budget for the current year, we observe that a sum of 21,639 dols. has been set aside for earthquake investigation. This is a grant over and above the usual expenditure of the Central Observatory controlling the seismic survey of the country.

THE monument to Lobachevsky will be unveiled this autumn at Kazan. It consists of a bronze bust of the late geometer, one metre high, placed on a column of black polished granite, about 50 centimetres in diameter and 1·4 metres high, standing upon two steps of grey unpolished granite. The total height of the monument is 3·6 metres, and its cost about 3,300 roubles (£330).

WE learn from the *British Medical Journal* that Prof. Behring has given the half of the Alberto Levi prize of the Paris Academy of Sciences, recently awarded to him (amounting to £1000) to the Prussian Government Fund for the Furtherance of Research on Serum Treatment. The moneys received by the official control stations, where the diphtheria antitoxin is tested before it is allowed to be sold, will also be paid into this fund.

THE National Academy of Sciences, acting on the request of the Secretary of the Interior of the United States, has reported a Commission to investigate the forestry problem, consisting of Charles S. Sargeant, Alexander Agassiz, Henry L. Abbot, William H. Brener, Arnold Hague, and Gifford Purchot. The Secretary will recommend to Congress an appropriation of 25,000 dols. to cover the expenses of the Commission.

GENERAL JOHN B. WOODWARD, under whose able administration the Brooklyn Institute developed into the largest local scientific society in the world, with a membership of 3700, died on March 7, of pneumonia, after a short illness. General Woodward was for many years President of the Brooklyn Institute, but declined re-election last spring. He held many other prominent stations, having been a general in the army during the war of the rebellion, a bank president, candidate for mayor of the city, and President of the Society of Titans, none of whom were less than six feet two inches high. He was sixty years old.

THE Brooklyn Institute has completed negotiations for the purchase of the collection of Lepidoptera made by the late Berthold Neumoegen, comprising 40,000 to 45,000 specimens comprising 13,000 to 14,000 species, upwards of 1000 being type-specimens. This is the finest collection in America. As much as 100 dols. was paid by Mr. Neumoegen for a single specimen in several instances. The Institute will also secure the collection of Jacob Doll, of over 55,000 specimens, and will employ Mr. Doll as curator. Edward L. Graef will present his collection of about 20,000 specimens. The Institute already owns the Calverley collection; and the aggregate of all will give it the most complete collection of Lepidoptera in the world.

THE opening of the bicycle season shows the importance of that vehicle as a means of locomotion, and its potency as a factor in promoting good roads. The New York and Brooklyn Bridge has just been made free to bicycles, a change which required an Act of the Legislature to secure it. The grant for paving in New York City this year includes 1,000,000 dols. for asphalt pavement in a total amount of 1,250,000 dols. The pneumatic tire has been applied to ambulances in Brooklyn with great success. The ingenuity of inventors is taxed to devise improvements in all parts and appliances of the machine; and while the New York Cycle Exhibition last January was the largest exhibition of any special machinery that has been held in America, the exhibition now in progress in Brooklyn adds several apparently useful novelties not shown heretofore.

THE Governor of New Jersey has signed the Bill ceding the palisades of the Hudson to the United States Government for a national park.

THE General Electric Company and the Westinghouse Electric Company have combined, and each will be allowed to use the patents of the other.

IN connection with the Hungarian Millennial Exhibition, which will be opened on May 2, a Congress of Mining and Geology will be held at Budapest on September 25 and 26.

THE third International Congress of Dermatology will be opened in London on August 4, and will terminate on August 8. The President will be Mr. Jonathan Hutchinson, F.R.S.

WE regret to record that Prof. Sappey, the distinguished anatomist, died at Paris on March 14. His elaborate "Treatise on Descriptive Anatomy" is one of the best contributions to anatomical literature published in any language. He was a member of the Section d'Anatomie et Zoologie of the Paris Academy of Sciences.

THE *Scientific African* states that Mr. M. A. Schlechter, of the Botanical Museum, Grünewald Strasse, Berlin, is about to start on a collecting tour in South Africa. He will visit the Coud-Bokeveld, Namaqualand, Transvaal, and the Limpopo and Zambesi rivers.

RUSSIAN astronomers are completing their arrangements for viewing the forthcoming eclipse of the sun. The Pulkova Observatory will send an expedition to the Lower Amur; the Academy of Sciences has chosen Novaya Zemlya for the seat of its operations; so has the Kazan Society of Naturalists; while the Geographical Society will send the Director of the Irkutsk Meteorological Observatory, A. V. Voznesensky, to Olekminsk, on the Lena, for meteorological observations. Prof. Glasenapp and L. G. Vuchikhovsky propose to go to Finland on their own account. The young Russian Astronomical Society (it was founded only in 1891) directs its chief attention to physical observations, and it will have three parties of observers, provided with photographic appliances. The chief station will be on the Lena, where the duration of the eclipse is the longest, and it is proposed to photograph there the corona by Schaeberle's method, with an objective of long focal length, and also to photograph, by means of two spectrographs, the spectrum of the corona, as well as the limb of the sun, by means of a camera provided with a Rutherford prism. At the second station, on the bay of the Ob, the corona will be photographed by means of several ordinary cameras; while at the third station, in the eastern parts of the Uleaborg province, to the north of Enontekis, the corona will be photographed by means of several cameras following the movement of the sun; and it is intended to establish a comparison between the spectrum of the corona and that of helium. The usual determinations of the duration of the eclipse will be made at the first and third stations.

MR. R. H. SCOTT has sent us a cutting from the *Diario Oficiel*, which records that on March 2 a well-marked earth-movement passed over the capital of Mexico at 0h. 24m. a.m., Mexico time, the direction being from north-east to south-west, and the duration about twelve seconds. The shock was recorded at other places as follows:—

Place.	Time. h. m.	Duration. s.	Direction.
Tecuitatlan	11 57	20	—
Colima	12 3	30	W.N.W. to E.S.E.
Morelia	12 12		S.S.E. to N.N.W.
Manzanillo	12 20	30	—

THE question as to the desirability of retaining the Museum of the Geological Society has formed the subject of long deliberations by the Council of the Society. It was announced at the recent annual meeting that, in accordance with the report of a special Committee, the Trustees of the British Museum had been asked whether they would undertake to house and care for the collections, keeping type-specimens and specimens illustrative of papers read before the Society distinct, and defraying also the expenses of transference. To these conditions the Trustees have assented, and the matter will before long be submitted to the Fellows for their decision at a special general meeting.

PROF. STROUD informs us that in obtaining photographs with Röntgen rays, the time of exposure can be reduced by placing a card covered with barium platino-cyanide immediately in front of, and in contact with, the sensitive plate. A very good shadow-picture of the bones of the fingers was thus obtained by Prof. Stroud with a two minutes' exposure, whereas without the fluorescent card an exposure of from twelve to fifteen minutes was required to give a similar result. It is suggested that the introduction of some suitable fluorescent substance (rendered active by X-rays) into the sensitive film of photographic plates would greatly shorten the time of exposure requisite.

THE gigantic extinct birds of the order "Stereornithes," which are peculiar to the Eocene beds of Patagonia, have been until lately quite unrepresented in the museums of Europe. Sir William Flower has just acquired for our National Collection the series of the remains of these birds belonging to Señor Florentino Ameghino, of Buenos Ayres. This includes a complete skull of *Phororachos inflatus*, which is of most extraordinary size and appearance, and the lower jaw of an allied species (*P. longissimus*), about two feet in length.

UNDER the name *Canis holubi*, Dr. L. V. Lorenz has lately described a new wild dog from Western Matabeleland. The specimens of this new species, received by the K.K. naturhistorische Museum of Vienna from Dr. E. Holub, had been previously assigned to *C. adustus*, Sund., but Dr. L. v. Lorenz (*Verh. Zool.-Bot. Ges.* in Wien, 1895) now points out the differences between these two nearly allied species. In a subsequent paper (*Ann. d. K.K. naturh. Hofmuseums*, xi. h. 1), Dr. Lorenz gives further particulars, and figures the skull of *C. holubi*.

UPWARDS of sixty ornithologists assembled on Wednesday, the 18th inst., at the monthly meeting of the British Ornithologists' Club, held at Frascati's Restaurant in Oxford Street. The proceedings were of special interest on account of the splendid series of more than 900 eggs of the Cuckoo, which were on view on this occasion, having been assembled together from the cabinets of various collectors by the energy of Mr. Edward Bidwell. Most of the Cuckoos' eggs were accompanied by clutches of the eggs of the foster-parents, in the nests of which the mother-cuckoo had placed them. There are about 110 foster-parents at present known of *Cuculus canorus*, and examples of the eggs of 76 of these foster-parents, accompanied by one or more Cuckoos' eggs, were exhibited to the meeting. The conclusions arrived at by Dr. Eugene Rey, as stated in a recent number of this journal (see NATURE, December 26, 1895, vol. liii. p. 176), were well illustrated by this excellent series, which was believed to be the largest ever got together on one occasion.

IN a recent number of NATURE, February 27 (vol. liii. p. 393), under the heading "The Destruction of Trees by Lightning," we gave an account of the investigations which had been carried out by Jonescu and others to determine, if possible, the reasons underlying the observed facts that some kinds of trees are more liable to be struck by lightning than others. It was there stated that the whole question seemed to turn on the nature of the tree—that is, whether it was a tree rich in resin, or one rich in starch; further, the degree of conductivity seemed to increase the less oil and the more starch the tree contained. Some interesting statistics are given in the current number of *Prometheus* (No. 336, p. 383), concerning the white poplar. In the neighbourhood of Moscow, out of 597 trees struck by lightning, no less than half of them—more accurately 302—turned out to be the white poplar. This fact is sufficient to show that the degree of conductivity of this tree must be very high, and it has been suggested that country people should plant these

trees for natural lightning conductors. The pyramid-poplar has also for a long time been known to be specially attached to the lightning flash, so that by planting many of these round the farmhouses they should form natural and inexpensive lightning conductors, more effective perhaps than many now in use.

ACCORDING to Hermann Feigl ("Die Religion der Chinesen," *Oesterreich. Monatsschr. für den Orient*, xxii., 1896, 1), the primitive belief of the Chinese has been suppressed by Confucianism and Buddhism. Chinese religion has never had the puerilities, the animal cults, the cruelties and fanaticism of other religions. Like the Jews, the Chinese had very vague ideas of future rewards and punishments and of life after death. Their ancestor cult had no mythologic motive like that of India or Japan. The Chinese, like the Jews and ancient Egyptians, had the philosophic conception that continuation of life lies not in the immortality of the soul, but in the perpetual remembrance of the righteous by mankind. The Chinese could not persevere with metaphysical problems, and so did not advance. Confucius appeared at a time when the Chinese felt the need of a religion; but the greatest of their religious reformers was Lao-tseu, who was born about 604 B.C., or half a century before Confucius. He introduced the word Tao, "way," for the idea of divinity, which previously was confused with the visible sky (Schang-ti). Tao is the element from which everything comes, and to which everything returns. Lao-tseu also taught that the departure of the soul from the body was no disaster for us. But he was too vague to be a convincing reformer. Confucius was not an original thinker like Lao-tseu; he culled what he liked from the older writers, and allowed people to believe what they chose. When consulted he spoke in an oracular manner, and while satisfying no one he offended nobody.

PERHAPS the most interesting region visited by H.M.S. *Challenger*, during her memorable expedition, was that designated by Dr. John Murray as the "Kerguelen Region of the Great Southern Ocean." Leaving the Cape of Good Hope on December 17, 1873, the *Challenger* proceeded in a south-easterly direction, visiting in succession Prince Edward and Marion Islands, the Crozet Islands, Kerguelen Island, and Heard Island, then southward, until on February 16, 1874, having reached longitude 78° 22′ E., some ten miles beyond the Antarctic Circle, she turned north-easterly, for Melbourne, arriving there on March 17, 1874. During this three months' cruise many trawlings were made, and some of the rarest and most remarkable forms were met with. Each one of the staff of writers will remember with what excitement and delight he approached the examination of the results of some of the deep-sea dredgings, from this region, especially the eight trawlings from the most southerly position reached, where the depth was between 1260 and 2600 fathoms. It is of this region, and of the zoological treasures found therein, that Dr. J. Murray writes in a memoir published in the early part of this year in the *Transactions* of the Royal Society of Edinburgh (vol. xxxviii.), thus enabling the student to obtain, within a brief compass, the story, as far as it is as yet recorded, of the marine fauna of this part of the ocean. After a short introduction, we have full lists of the Metazoa found by the *Challenger*, arranged according to the depths. About some of the islands, Kerguelen especially, many of the species were taken from quite shallow water; this is followed by a list of Metazoa recorded from sources other than the *Challenger*, a list of great importance for purposes of comparison. A list is given of identical or closely-related forms, found in the extra-tropical regions of the Northern and Southern hemispheres, but unknown hitherto within the tropics. There are also lists of the Foraminifera, Diatoms, and surface organisms of the region, and of the Radiolaria found in the deposit dredged from a depth of 1950 fathoms, at Station 157 in the Southern Indian Ocean.

PROF. E. C. PICKERING has communicated to the *American Meteorological Journal* for this month, the results of an investigation carried out by Prof. S. I. Bailey, on the diurnal oscillation of atmospheric pressure at the Peruvian stations of Harvard College Observatory. The stations, which are eight in number, are situated along a line nearly four hundred miles long, drawn approximately north and south across the Andes. The lowest station has a very small elevation above the sea-level, while the highest, that on the Misti summit, has an altitude not far short of 20,000 feet, the others being admirably chosen with a view to obtaining meteorological results from a great variety of elevations. The stations are well supplied with instruments, including in every case a Richard barograph, although no mercurial barometer has been regularly in use at any station except Arequipa Observatory. The natural difficulties of visiting the Misti summit have been increased by the civil war, and in consequence of this the continuity of the record has suffered. Energy less active than that possessed by Prof. Pickering and his assistants would have led to the evacuation of the station. At Arequipa Observatory (elevation 8000 feet), where the annual range of the barometer varies from 22·626 inches to 22·404 inches, a comparison was made between the results obtained from the mercurial barometer and the Richard barograph, and after a certain uniform correction had been applied to the latter, it was found that the monthly barographic means were liable to an error as great as 0·034 inch, and that the mean error for the year was 0·013 inch. At all the stations the diurnal oscillations are well marked, and very uniform from day to day. There are striking differences, however, between the records in the different localities, especially in the hour of the morning maximum, and the intensity of the afternoon maximum and minimum. The paper contains the curves for the mean diurnal variation for the year April 1894–March 1895, together with the corresponding values for a single day, selected at random, and the investigation points out this important result, that "from these curves it appears that the retardation of the morning maximum is at least, in part, a function of the altitude." The diagram shows that the time of maximum near the sea-level is 9 a.m.; at 4000 feet, about 9h. 20m.; at 8000 feet, about 9h. 40m., while at the Misti summit the maximum pressure is near noon.

THE Pilot Chart of the North Atlantic Ocean for the current month contains a chart showing the tracks of the storms during March for the six years 1890–95, north of the 35th parallel and west of the 30th meridian. The diagram shows that the portions of the North Atlantic within the prescribed limits in which storms are most frequent during March are (1) the region immediately to the east of Cape Hatteras and the New Jersey coast, and (2) the area included between the parallels of 45° and 50°, and the meridians of 30° and 40°. Each track bears a number, by which the date of the appearance of the storm may be obtained by reference to a table. The information is both interesting and useful, and no doubt similar tracks will be given for other months.

THE Zi-ka-wei Observatory has published the first of a proposed series of papers entitled "Typhoon Highways in the Far East." The present paper is by the Rev. L. Froc, S.J., and refers to the storms which have occurred near the south end of Formosa Strait, between 1877 and 1895, and especially to the typhoon of September 19 last. The principal conclusions arrived at are (1) that a violent typhoon may be expected to traverse the south end of the Formosa Channel at least once a year; (2) the direction from the South Cape varies between N. 20° W. and N. 85° W., the *ensemble* of the storms forms a kind of fan, whose point lies upon the south end of Formosa Island, and which thence spreads out to the coast of China; (3) the period of occurrence is from the middle of July to the beginning of

October; a curve of the monthly frequency shows that a considerable maximum coincides with the equinox. The most striking characteristics are the suddenness of their appearance and the narrowness of the storm area; in some cases Father Dechevrens has shown that the diameter did not exceed fifty miles, and that the velocity of translation may vary from eight to twenty-six miles per hour. The author discusses, at some length, the various signs which precede the occurrence of the typhoons.

THE numbers of the *Naturwissenschaftliche Wochenschrift* for February 16 to March 8 contain an account, by Dr. H. Hallier, of a botanical investigation of Central Borneo, organised at the instance of the Dutch Government, under the direction of Dr. Treub, of Buitenzorg. This portion of the island is an almost unknown land from a natural history point of view; previous explorations having been made from Sarawak, Labuan, British North Borneo, and Dutch South Borneo. A very large collection was made, calculated to amount to about 3000 distinct species of dried plants, as well as a considerable quantity of alcohol material, and many living roots. These are now being examined at the Botanical Institution at Buitenzorg. The mountain K'nepai was ascended, about 1125 metres high. Its flora is described as being especially rich in Orchideæ and in species of *Nepenthes*.

THE interesting question has been recently again raised, by Messrs. Gotschlich and Weigang, as to whether the virulence of cholera cultures is dependent upon the number of bacilli present, or whether the age of the culture affects the toxic character of the individual bacilli. Estimations have been made of the number of bacilli present in cholera cultures at different periods of time, and it has been found that a rapid diminution takes place with the increasing age of the culture. Thus at 37° C. at the end of two days, only 10 per cent. remained of those present at the close of the fully virulent age of twenty hours, whilst after three days only 1 per cent. were left. Messrs. Gotschlich and Weigang have also determined the approximate number of individual cholera bacilli which constitutes a lethal dose, and this they state to be from 200 to 300 million bacilli, and that as long as this number is present, it is a matter of no consequence whether the dose is abstracted from a twenty hours' old culture or from a three days' old culture. The apparent diminution in the virulence of cultures some days old, is not due to the attenuation of the bacilli at this age, but is attributable to a smaller number being present in the culture, for equally fatal results were obtained when larger quantities of such cultivations were employed.

PSYCHOLOGY has found in America a congenial field for development, one of the clearest marks of its vitality there being the excellent *Psychological Review*. The March number of that journal contains the address recently delivered by Prof. McKeen Cattell as President of the American Psychological Association; and how great has been the academic recognition of the subject in America during the past few years is shown by his remark, that "psychology is a required subject in the undergraduate curriculum wherever studies are required, and among university courses psychology now rivals the other leading sciences in the number of students attracted, and in the amount of original work accomplished." The following other indications of growth are recorded in the same journal:—The psychological department of Cornell University has moved to Morrill Hall, where it is said to have nine rooms and four thousand square feet of floor space. The psychological laboratory of the University of Nebraska has been moved into the first-floor of the new library building, and occupies a series of five rooms with a floor space of three thousand square feet. In the new biological buildings, which the University of Chicago will erect with a part of the million dollars given by Miss Culver, ample provision will be made for the psychological laboratory. In the new Schemerhorn Hall of Natural Sciences, to be erected for Columbia University at a cost of about 400,000 dollars, more than one-tenth of the building is allotted to psychology. At this rate of progress, America will soon rival Germany in psychological laboratories and productions.

THE Académie Royale de Belgique announce the following prize subjects for 1897:—New researches on the thermal conductivities of liquids and solutions. An important contribution to the geometry of straight lines. A discussion, from the theoretical point of view, of the question of variations of latitude, and their causes, the paper to include a criticism of the works of geometers on the subject, from Laplace to the present time. New researches on the physiological *rôle* of albuminoid substances in the nutrition of animals and plants. New anatomical and systematic researches on insects of the group Aptera. Does there exist a nucleus in Schizophytes? If so, what is its structure, and what its mode of division? A discussion of the changes made in the classification of the deposits which constituted the *Laekenian* system of Dumont, most of which are usually referred to the Upper Eocene; to bring forward new evidence in support of the classification adopted. The value of the prize to be awarded for the best work in each of these subjects is six hundred francs. Memoirs may be written in French or Flemish, and should be addressed to the Secretary of the Belgian Academies before the beginning of August next year.

MESSRS. WILLIAMS AND NORGATE have just issued a classified list of recent scientific publications, chiefly of foreign origin. Book-hunters seeking scientific works would do well to consult the list.

MR. HIRAM S. MAXIM is contributing a series of illustrated articles on "Automatic Firing Guns" to *Industries and Iron*.

A PAPER on "The Food and Labour-Power of Nations," contributed by Prof. F. S. Nitti to the March number of the *Economic Journal*, contains a large number of facts and figures of interest from a physiological, as well as from an economic and social, point of view.

THE Tōkyō Mathematico-Physical Society has recently published in its *Proceedings* a reprint of Clifford's Translation of Riemann's Habilitationschrift (1854), viz. on the hypotheses which lie at the bases of geometry (NATURE, vol. viii. Nos. 183, 184, and *Mathematical Papers*, pp. 55–71).

AN elaborate discourse on Helmholtz's investigations on the "Grundlagen der Mathematik und Mechanik," which was delivered in November last at Heidelberg University, by Prof. Leo Koenigsberger, the occasion being a celebration in memory of the founder of the University, has now been published by B. G. Teubner, of Leipzig. A photogravure of Helmholtz forms a frontispiece to the reprint.

WE are glad to receive from the agricultural department of the University Extension College, Reading, the second annual report of field experiments on hay, pasture, potatoes, swedes and mangels, carried out in Berkshire, Hampshire, and Oxfordshire, during 1895, under the direction of Mr. Douglas Gilchrist and Mr. P. H. Foulkes. A notable feature of the work is that it was carried out on land placed at the disposal of the experimenters by various land-owners and farmers, who also gave assistance in the actual superintendence and cultivation of the plots. Two important Farmers' Clubs have also co-operated in the work. By thus enlisting the help of farmers, interest in agricultural experiments is greatly increased, and the results are more likely to command the attention of practical men than if they were obtained by flower-pot cultivation.

THE opening address for the Session 1894–95, delivered to the Royal Physical Society of Edinburgh by Prof. H. A. Nicholson, has recently been published in the *Proceedings* of that Society, and will be found to be an admirable summary of the evidence that has accumulated of late years against the doctrine of Ocean Permanence. The distribution of land and sea in former periods is discussed, and the truly abyssal characters of certain sediments now forming part of continental masses are pointed out in some detail, while mention is made of the evidence for a former Antarctic continent, and other matters are more briefly discussed.

A RECENT number of the *Annali* of the Meteorological and Geodynamic Office of Rome contains an interesting paper, by S. Arcidiacono, on the Syracuse earthquake of April 13, 1895. The disturbed area comprises the south-east corner of Sicily. On the map which accompanies the paper, eight isoseismal lines are drawn, corresponding to intensities 1 to 8 of the Rossi-Forel scale. These are elliptical in form, and have a common axis running from Cape Passero in a north-westerly direction through Vizzini, which is close to the centre of the meizoseismal curve. Applying the method of Dutton and Hayden, the depth of the seismic focus is estimated at about 7400 metres. The axis of the isoseismals coincides nearly with that of the ridge of Monte Lauro, and joins the two principal volcanic centres, now extinct, of the Val di Noto.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*, ♂) from north of River Prah, Ashanti, presented by Captain Edgar E. Bernard; an American Tapir (*Tapirus americanus*, ♂) from Brazil, presented by Mr. Basil J. Freeland; a Markhoor (*Capra megaceros*, ♂) from Peshawur, presented by Colonel Paterson; three Canarian Laurel Pigeons (*Columba laurivora*) from the island of Gomera, Canary Islands, presented by Mr. E. G. B. Meade-Waldo; a Common Mynah (*Acridotheres tristis*) from India, presented by Mrs. Sibyl E. Kennedy; a Herring Gull (*Larus argentatus*), British, presented by Dr. E. Goddard; two Grey Ichneumons (*Herpestes griseus*) from India, deposited; two Amherst Pheasants (*Thaumalea amherstiæ*, ♀ ♀) from Szechusan, China; two Swinhoe's Pheasants (*Euplocamus swinhoii*, ♂ ♀) from Formosa, a Bar-tailed Pheasant (*Phasianus reevesi*) from North China, two Great American Egrets (*Ardea egretta*) from America, a Porto Rico Pigeon (*Columba corensis*) from the West Indies, a Vinaceous Pigeon (*Columba vinacea*) from South America, two Rosy Parrakeets (*Palæornis rosa*, ♂ ♀) from Burmah, two Musky Lorikeets (*Trichoglossus concinnus*, ♂ ♀) from Australia, purchased; two Barbary Wild Sheep (*Ovis tragelaphus*, ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE FIFTH SATELLITE OF JUPITER.—The opposition of Jupiter in 1894 occurred at a very unfavourable time for observations at Mount Hamilton, but a few measures of the fifth satellite were secured with some difficulty by Prof. Barnard. During the observations of the satellite, the planet was obscured by a piece of smoked mica covering half the field. For the measurement of distances the micrometer wires were usually placed perpendicular to the belts on the planet; but on November 18 they were set parallel to the belts, and these measurements accordingly enable the Jovian latitude of the satellite to be determined. Only one eastern elongation was observed. This was on December 3, and the distance was found to be 59″·5; or, reduced to the mean distance of the planet = 5·20 astronomical units, 48″·17. On this date the elongation occurred at 23h. 43·6m. G.M.T., the corresponding time in Marth's ephemeris being 23h. 42m. G.M.T., so that the observed time was over a minute behind the computed time. The ephemeris is based on a period of 11h. 57m. 22·6s., and the observed elongation indicates that this period will represent the motion of the satellite with sufficient accuracy to find it for several years to come (*Astronomical Journal*, No. 367).

THE YERKES OBSERVATORY.—Additional particulars as to the proposed equipment of the new Yerkes Observatory of the University of Chicago are furnished by Bulletin No. 1, the first of a series of notices which will be published at irregular intervals in the *Astrophysical Journal*. The resident staff is to consist of Messrs. Hale, Burnham, Barnard, Wadsworth, Ellerman, and Ritchey, the last-named as optician. The 40-inch object-glass has been completed by Mr. Alvan Clark, and recent tests have shown the definition to be fully equal to that of the Lick telescope, while the light-gathering power is considerably greater. Electro-motors are provided to give the various movements to the instrument and to the elevating floor. The attachments to the great telescope include a solar spectroscope, a spectroheliograph for photographing the solar chromosphere in monochromatic light, a stellar spectroscope, and a photoheliograph of long focus for photographing the direct image of the sun on a large scale. A 12-inch refractor and a 24-inch reflector will also be erected. The meridian-room is designed to contain a large meridian circle, but will be provisionally occupied by a transit instrument. An instrument shop and optical laboratory will be fully equipped with the necessary tools, and it is hoped that it will be possible to construct many of the instruments and laboratory apparatus which may be required in occasional investigations. The main building is now under roof, and will be completed during the summer.

THE PROPER MOTION OF τ TAURI.—A discussion of the meridian observations of τ Tauri, which has been undertaken by Dr. Fritz Cohen (*Ast. Nach.*, 3341), indicates a variable amount of proper motion in declination, but there is less certainty as to the motion in right ascension. For an explanation of the irregularities it is suggested that the star is attended by a dark companion similar to that associated with Procyon, and only giving evidence of its existence by its gravitational effects on the brighter star, causing it to describe an orbit round the common centre of gravity. It is true that the star is already known to be double, the magnitudes of the components being 4·5 and 8·5; but the distance of the visible companion is so great (79″), that the detection of an orbital movement in the comparatively short period covered by the meridian observations is scarcely probable. There is an increase of 11″ in the distance measured in 1823 as compared with that determined in 1783, but as the distance and position angle in 1823 agree substantially with those in 1895, the earliest recorded measure is not to be depended upon. An investigation of the movements of the star by means of micrometric measurements in relation to neighbouring stars is suggested. The association of dark bodies with bright stars, in some cases producing variability either by eclipses or other means, but in others having no appreciable effect on the brightness, is a very notable feature of recent astronomical discoveries.

TWO REMARKABLE SOLAR PROMINENCES.—Father Fenyi reports the observation of two very striking solar prominences (*Astrophysical Journal*, vol. iii. p. 192). One observed on July 15 last was remarkable for its enormous velocity of 858 km. per second in the line of sight; the other, on September 30, for its great height of 11′ 28″, which it attained with a mean velocity of 448 km. per second.

The first one was found precisely at a point on the sun's limb where a group of sun-spots was passing out of view, and its form changed with extraordinary rapidity.

The second prominence was unusually bright, and at 10 a.m. was about 1′ high; eleven minutes later it had mounted to 4′, and the maximum altitude of 11′ 28″ was reached at 10.20, the velocity in the line of sight then being 746 km. per second. Half an hour from the beginning, the prominence was only 3′ 16″ above the photosphere. The spot associated with the latter prominence showed a considerable proper motion in the earlier days of its existence, amounting to about 600 km. per hour The convergence of some of the brighter "stream lines" of the prominences towards a spot was especially marked in these observations, and it is suggested that they have a radial arrangement with respect to the spots. This structure seems to point to the existence of currents in the solar atmosphere, directed either towards the interior of a spot, or outwards from it.

It is stated that an explosion taking place over a sun-spot would accord well with the appearances usually seen in the great prominences which have been observed at Kalocsa, but it is by no means asserted that actual explosions take place.

THE MEASUREMENT OF DOUBLE-STARS BY INTERFERENCE.

An interesting form of micrometer is described by Herr Karl Schwarzschild in *Astronomischen Nachrichten*, No. 3335. The idea is gathered from the instrument which Michelson suggested and used for measuring small diameters and distances, an account of which appeared in the *Memoirs* of the National Academy of Science, Washington, 1891. Michelson, it may be remembered, placed before the object-glass of his refractor a disc in which were two parallel movable slits that set up interference phenomena; and an observation consisted in noting simply the disappearance and reappearance of the interference bands. Schwarzschild's disc, or more accurately oblong framework, on the other hand, contains several slits cut out at equal distances from one another, which cause several images to be visible at the eye-end of the telescope, forming a true multiple-image micrometer.

If one considers the case of the ordinary glass grating as used in spectroscopic work, it is well known that with a bright point as the source of light, we obtain a series of images, the angular distances of which from the unrefracted central image, for a certain wave-length, are given by the formula sin $\alpha = \lambda . n/d$, when λ is the wave-length, d the distance between the lines on the grating, and n their number. In the case of daylight the centre image becomes sharp and white, while the others become broader and broader, in fact small spectra. By exaggerating this idea of the grating, and cutting out of a card slits three millimetres broad and ten millimetres distant from one another, the angular distances of the images for wave-length $\lambda = 570\,\mu\mu$ become very small, and can hardly be separated with the unaided eye. Such a grating as this placed before the object-glass of a telescope directed to a star would show, in the field of view, one colourless image accompanied on its right and left sides by several other images, the first of which would differ only slightly in sharpness and colour from the middle image. It is only to these three images that Schwarzschild pays attention. Of course it is necessary that some means should be at hand by which these images may be moved with respect to one another, and this he accomplishes very simply.

To the object-glass ring, and in a plane parallel to it, he fixes a framework capable of rotation in this plane. Two circular rods, at opposite ends of a diameter of the object-glass, and perpendicular to the framework, are rigidly fixed to the latter, and to these rods is connected the apex of two inclined smaller frameworks containing the slits, the other two extremities of which slide in the grooves of the large frame. Since the distance of this apex from the object-glass can, by means of a rack and pinion movement, be increased or decreased, and since also the distances of the different slits vary consequently in a simple known manner, the displacement of the images in the field of view can be easily calculated.

In bringing a double star into the field of view, two parallel series of images would thus be seen, one series from the primary, the other from the companion. The whole framework containing the grating was then rotated in position-angle until the two lines of images coincided; the position of this line was then determined by means of a micrometer eyepiece, and the position-angle read off. To measure the distance between the stars, the rack and pinion motion connected with the apex of the two frames containing the grating was then used, until the image of he companion appeared exactly between the two images of the primary. The position of the grating was then read off, and a brief calculation gave the distance required. From a series of observations of several binaries, the total mean gave as a probable error of the mean for each evening:

Distance	Probable error in Distance	Probable error in Position angle
2″·3	0″·050	0″·052

The numbers show, as Herr Schwarzschild points out, that greater accuracy can be obtained by this means than by the thread micrometer. He is not, however, very confident about the usefulness of the method, for when the distances to be measured exceed 5″, the colour of the first images becomes very apparent, and thus destroys the accuracy in measuring. Further, the nature of the method stops it from being useful for measuring pairs dimmer than the 7th magnitude, because the aperture of the object-glass is cut down very considerably when the grating is much inclined and the light is distributed over several images. The simplicity of the method has, however, much to recommend itself to many, more especially to those who possess large apertures, and can therefore afford to spare a little light.

D.

FLORA OF ZERAFSHAN.

In a communication to the St. Petersburg Society of Naturalist (*Proceedings*, 1895, i.), M. Komaroff thus sketches the flora of the Zerafshan region of Russian Turkestan. The Aral-Caspian flora covers the lowlands up to the 1000 to 1500 feet level. Next comes the prairie, or Steppe, zone, which spreads up to about 3500 feet of altitude. In its upper parts it is characterised by Steppe-bushes, of which the almond-tree (*Amygdalus spinosissimus*, Bunge) is the most characteristic representative. Higher up, from 3500 to 6000, or 6200 feet, comes the zone of deciduous trees, which may be subdivided into a lower sub-zone of Mediterranean trees (*Pistacia vera*, *Celtis australis*, *Amygdalus communis*, *Acer monspessulanum*, &c.), with a prevalence of fragrant Labiatæ, which attains approximately the 4500 feet level; and an upper sub-zone characterised by maple-trees (*Acer lactum*). The zone between 6000 feet and nearly 8500 feet is taken by the Juniperus-trees which correspond in Zerafshan to the coniferous trees of other regions. It is covered at its upper limits with rampant bushes of *Juniperus nana* and *pseudosabina*, *Comarum*, *Cotoneaster*, *Lonicera*, *Astragalus*, and so on. The Alpine zone attains the levels of 11,000 and 12,000 feet—the morainic plants, *Didymophysa fedtschenkoana*, *Corydalis fedtschenkoana*, *Cerastium lithospermifolium*, *Saxifraga axillaris* and *Allardia tomentosa* reaching the highest altitudes. On the Zerafshan glacier, at a spot where it was covered with some gravel, the author found specimens of *Saxifraga axillaris*, *Epilobium latifolium*, *Arabis tibetica*, *Poa karataviça*, and one *Carex*—a fact which shows how careful one must be in interpreting the real sense of plant-bearing strata imbedded amidst morainic deposits. It is also worthy of note, that the botanic zones of Zerafshan very much correspond to the zonal geological structure of the highlands. The Aral-Caspian flora covers the æolic deposits of the great desiccated inner sea of Central Asia; the Steppe flora covers the Loess girdle; the Mediterranean trees and shrubs occupy the limestones and the marls, while the Juniperus zone spreads over the crystalline slates and limestones, and the Alpine flora covers the higher granitic massives of the highlands. Man evidently alters to a great extent the character of the vegetation—pistachio-tree groves and the *Juniperus excelsa* trees being rapidly destroyed; while the hundreds of thousands of sheep which are brought every year to the Zerafshan mountains from the lowlands, entirely destroy the Alpine prairies—thickets of *Artemisia dracunculus* taking the place of the grasses.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—One of the arguments which are brought forward for granting the degree of B.A. to students from Newnham and Girton Colleges is that, when they apply for educational positions, they are at a disadvantage as compared with students from other universities which do grant the degree of B.A. Dr. W. H. Besant points out in a circular, which he had addressed to the members of the Senate, that this difficulty would be entirely removed if a charter were granted to Newnham and Girton Colleges, creating a Women's University, which should have the power of granting degrees. This need not interfere with the present arrangements for the teaching and for the examination of the students in the various subjects, the study of which they now undertake. Mr. J. L. Strachan-Davidson has suggested that Oxford, Cambridge, and Dublin—the three universities which have not as yet conferred degrees on women—should join in a petition to the Crown to grant a charter for a university whose sole function it shall be to give degrees to women. A scheme similar to that supported by Dr. Besant has been practically adopted by the University of Harvard.

The members of the Skinners' Company visited Tonbridge on Saturday last, for the purpose of opening a new second-grade school which they have just built at a cost of upwards of £10,000

THE following are among recent appointments:—Dr. C. A. Strong to be lecturer on psychology in Columbia University; Mr. H. C. Warren to be assistant professor of experimental psychology in Princeton University; Herr H. Hinterberger to be professor of photography in the University of Vienna; Prof. James Holm, of University College, Nottingham, has arrived at Cape Town, to succeed Prof. Smith as professor of applied mathematics and physics in the South African College; Prof. G. F. Atkinson to be full professor and head of the department of botany in Cornell University; Mr. Arnold Philip to be professor of electrical engineering and applied physics in the Merchant Venturers' Technical College, Bristol, in place of Prof. W. Wilson, who will shortly vacate the chair in consequence of his appointment to the post of principal of the Salford Municipal Technical School.

THE plans and drawings of the Women's Medical Institute, the new Russian college for granting medical diplomas to women, are, says the *Lancet*, completed. The building operations will begin next month, and it is hoped that they may be finished in time to open the new institution in August of next year. It has been liberally subsidised by Government and by the municipality of St. Petersburg, and private subscriptions and donations have been neither few nor small. At present the whole capital amounts to about 600,000 roubles (nearly £64,000). But of this at least 450,000 or 475,000 roubles will be required for building and furnishing the institute. The late Prof. Tchudnofski, whose recent death has created a vacancy in the chair of General Therapeutics in the Army Medical Academy, has left to the Women's Medical Institute his entire medical library, containing over 4000 volumes. The number of students who will be admitted to the courses at first has been fixed at 125. Already over 100 applications have been received.

YALE UNIVERSITY is having a run of good fortune. The widow of Thomas G. Sloane will remarry soon after Easter, thereby forfeiting to Yale the sum of 200,000 dols. left by her first husband on condition of her remaining unmarried. She will let the money go without a contest. The will of the late George Bliss, of the great banking house of Morton, Bliss, and Co., was admitted to probate in New York on March 11. Among the bequests is one of 50,000 dols. to Yale, to be disposed of as the President of the University shall direct. A new dormitory is to be erected on the college *campus* this season, at a cost of nearly 100,000 dols. Ground was broken on March 9. at Washington, for the new American University, the Hall of History being the first building to be erected. This is a university of the Methodist Church, and Bishop Hurst of that Church presided. About 1,000.000 dols. has been secured towards the University fund. This should not be confounded with the proposed University of the United States. Nothing has yet been done regarding the latter, except the introduction of a Bill in Congress; and the fate of the measure is still problematical.

WHEN shall we be able to chronicle so many gifts from private persons to science and education in England as the following, which *Science* announces in a single number?—The will of the late Mr. Hart A. Massey, of Toronto, leaves about 650,000 dols. to educational and charitable institutions, including the following bequests: Victoria College, Toronto, 200,000 dols.; Wesley College, Winnipeg, Man., 100,000 dols.; Mount Allison College, Slackville, N.B., 100,000 dols.; Wesleyan Theological College, Montreal, 50,000 dols.; American University, Washington, D.C., 50,000 dols.—The Finance Committee of the Senate of the State of Virginia has presented a Bill appropriating 50,000 dols. annually, instead of 40,000 dols. as heretofore, to the University of Virginia.—The will of the late Mr. Charles L. Colby, of New York, bequeaths 20,000 dols. to Brown University.—Morris M. White and Francis T. White have given to Earlham College, a Quaker institution in Richmond, Ind., 25,000 dols., to be added to the endowment fund and to be known as the John T. White memorial fund, in honour of their father.—Mrs. Josiah Fiske, of New York City, has given 5000 dols. to Radcliffe College, in memory of her late husband. The College has also received 6568 dols., the balance of a bequest by the late Caroline B. Perkins.—Mr. T. E. Bondurant, of De Land, Ill., has offered to give 20,000 dols. to the endowment fund of Eureka College, Illinois, provided the Board of Trustees will secure 100,000 dols. additional by March 1, 1897. Mr. T. J. Underwood, of Sangamon County, Ill., has donated 10,000 dols. towards the fund.

A RETURN made to the Department of Science and Art, showing the extent to which, and the manner in which local authorities are applying funds to the purposes of technical education (including science, art, technical and manual instruction), has been published as a Parliamentary Paper. The return shows that the total expended on technical education during the year 1893-94 in England, Wales, Scotland, and Ireland was £647,632; and that the estimated total expenditure on technical education for the year 1894-95 was £737,421. These amounts are exclusive of the sums devoted to intermediate and technical education under the Welsh Intermediate Education Act. In England, 41 out of the 49 County Councils (excepting the County of Monmouth) are applying the whole of the residue received under the Local Taxation (Customs and Excise) Act to technical education, and 8 County Councils a part of it to the same purpose. Of the Councils of the 61 County Boroughs, 55 are devoting the whole of the residue to technical education, and 8 a part of it; while in one case only, the County Borough of Preston, the residue is not being applied to educational purposes, but to relief of rates. Further, the Councils of 11 County Boroughs, 51 Boroughs, and 86 urban districts are making grants out of the rates under the Technical Instruction Acts; and 8 local authorities are devoting funds to technical education out of the rate levied under the Public Libraries' Act. In Wales and Monmouth, the 13 County Councils and the Councils of the 3 County Boroughs are devoting practically the whole of the residue grant to intermediate and technical education, and several Councils are making grants out of the rates. As regards Scotland, 21 out of the 33 County Councils are applying the whole of the residue to technical education, and 9 a part of it, while 3 use it for the relief of rates. Of the 195 Burghs and Police Burghs, more than half (101) apply the whole of the grant to the relief of rates.

DESPITE Prussia's open secret of a Treasury exhausted for the Army vote, and the consequent amenities between the Ministers of Education and Finance, the necessity of maintaining the trade schools in some degree of efficiency is present to the German official mind. The want of funds applicable to educational purposes in Prussia, is among the causes making for the spread of social democracy, and this is particularly the case in the straitened salaries of the teachers of the *Volksschulen*. A review of the Technical Education item in the Prussian Budget for the last five years shows, however, a healthy growth. For altogether, apart from the continuation schools in West Prussia and Posen, for which special provision is made, the grant for 1895-96 was 1,947,257 marks (£97,362 17*s*.), which was an increase in the total State subvention of £22,304 14*s*., or nearly 30 per cent. of the entire grant. To take the trade schools (*Fachschulen*) alone, these were especially well treated. The State's expenditure on them rose from 896,993 marks (about £44,850) in 1891-92, to 1,263,157 marks (about £63,158) in 1895-96, or by more than 40 per cent., while their internal history shows an equally satisfactory development. In 1891-92 there were forty-four trade schools subsidised by the Treasury. Of these, four of the least significant have since been closed, while, on the other hand, no less than eight new ones have been started, involving a vote for the current year of more than £10,500. Three of these new schools are for building, two for weaving, one for pottery, one for engineering, and one for art industries. Similarly, the contribution to the continuation schools (*Fortbildungsschulen*) reveals an increase by more than 20 per cent., from £22,000 in 1891-92 to £26,500 in 1895-96. These figures are at least reassuring, and give hope that during the present year the Treasury will not look askance on the Education Office when it begs for money for the growth of its good work.

SCIENTIFIC SERIALS.

American Meteorological Journal, February.—The rainfall of the Malay Archipelago, by Dr. A. Woeikof. This article is chiefly based upon the observations which have been for fifteen years published in considerable detail by the Observatory of Batavia. It is generally considered that near the equator the rains are everywhere heavy and of nearly daily occurrence. Dr. Woeikof shows that in many localities, *e.g.* on the open sea, this is not the case. In the region in question, some of the wettest and some of the dryest stations lie within $1\frac{1}{2}°$ N. and 1° S. of the equator. The most rain falls on the west coast of Sumatra; the more level Eastern Sumatra and Western Borneo

have less rain, and less contrasts also. On the north-east of the peninsula of Celebes the rains are comparatively light, and there is a well-marked dry season. In Java, the rainfall is lightest in the east, and the dry season is longer and more sharply defined, so that vegetation has a time of arrest corresponding to our winter.—Psychrometer studies, by Prof. H. A. Hazen. This is a continuation of a discussion between Prof. Hazen and Dr. Ekholm, of Stockholm, on the behaviour of the psychrometer with respect to water vapour and ice vapour.

Bulletin of the American Mathematical Society, vol. ii. No. 5, February.—"Remarks on the progress of celestial mechanics since the middle of the century" is the presidential address delivered before the Society on December 27, 1895, by Dr. G. W. Hill. The address opens with the statement that a thoroughly satisfactory history of the subject has yet to be written, and then the author rapidly analyses some of the books that touch upon it, as Gautier's "Essai historique sur le problème du trois corps" (1817), Laplace's historical chapters in the last volume of the "Mécanique Céleste," Todhunter's "History of the Theories of Attraction and the Figure of the Earth," and Tisserand's "Traité de Mécanique Céleste." The scarcity of memoirs and books on the same subject accessible to American students, unless they work abroad, is dwelt upon, and then Dr. Hill opens with a consideration of Delaunay's method (*cf.* his "Théorie du Mouvement de la Lune"). Pointing out that Delaunay's method has not yet received all the developments and applications it is susceptible of, he next merely mentions Hansen's treatise on the perturbations of the small planets, and then confines his attention to a careful examination of the labours of Prof. Gyldén and M. Poincaré. He here enters into considerable detail, and closes with the remark that we owe much to M. Poincaré for his attack, "but the mist is not altogether dispelled; there is room for further investigation." This last remark is made with reference to the Lindstedt series, which "if convergent, would establish the non-existence of asymptotic solutions" (*cf.* a paper by the same author in the January number of the *Bulletin*, noticed in NATURE, No. 1373, p. 382).—A short note follows on Kronecker's linear relation among minors of a symmetric determinant, by Prof. H. S. White.—Dr. G. A. Miller's note on the lists of all the substitution groups that can be formed with a given number of elements, is a valuable historical *résumé* of recent and past work in this subject.—On Cauchy's theorem concerning complex integrals, by Prof. M. Bôcher, closes the mathematical papers.—From the Notes we learn that Prof. White's paper was read before the Society.

In the December number of the *Botanical Gazette* (vol. xx.), Mr. Frederick V. Coville, the Botanist of the U.S. Department of Agriculture, contributes a very interesting account of the botanical explorations of Dr. Thomas Coulter in Mexico and California, between the years 1824 and 1834. Among the chief botanical explorers in North America during the first half of the present century was Coulter. His collections were the basis of important contributions to the descriptive botany of Mexico and California. Born near Dundalk, Ireland, in 1793, he graduated in the Dublin University in 1817, studied under De Candolle at Geneva, and published his monograph of Dipsaceæ in 1824. He was Keeper of the Herbarium of Trinity College, Dublin, from 1834 to 1843. This account is accompanied by a copy of the principal part of the map published with Coulter's "Notes on Upper California," and Mr. Coville adds that he hopes in the near future to publish the letters of Coulter to A. Pyramus and Alphonse De Candolle, of which, through the courtesy of Dr. Casimir De Candolle, he has had copies. He further earnestly begs for any additional facts relating to Coulter, which should be sent to him to the Agricultural Department, Washington, U.S.

L'Anthropologie, Tome vi. No. 6.—Researches on the weight of the brain among the lunatics at St. John's Hospital, Copenhagen, by F. Meyer and P. Heiberg. In these investigations, which have extended over more than ten years, the authors have excluded brains that have suffered great loss of substance, those that have been the subjects of considerable cerebral hæmorrhage, and those that presented large tumours; on the other hand, brains suffering from œdema, anæmia, hyperæmia, atrophy, or periencephalitis have been included. The mean weight of 398 brains of men was found to be 1320 grammes; the greatest weight was 1866 grammes, and the least 995 grammes. 292 brains of women were examined; the mean weight was 1177 grammes, the heaviest weighed 1509 grammes, and the lightest 780 grammes. It appears that the brain gradually diminishes in weight after about fifty years of age.—On marriage amongst the Polynesians of the Marquesas Islands, by Dr. Tautain. Some of the marriage ceremonies described by the author clearly point to a time, not very remote, when all the women were common property, and marriage was unknown. A man on his marriage acquires the right of a husband over all his wife's sisters, and at the same time his brothers are entitled to exercise similar privileges with respect to the newly-made bride. In the author's opinion the Marquesans are a degraded people, and do not deserve the least sympathy.—Prehistoric stations in the neighbourhood of Marseilles, by E. Fournier. In this paper are recorded the results of digging operations at 110 stations, 45 of which have yielded evidence of the fauna and of prehistoric industry. They may be arranged in four groups: (1) The Magdalenian, (2) those belonging to the transition period, (3) the Lower Neolithic, (4) the Upper Neolithic.—Sculpture in Europe before Græco-Roman influence, by Salomon Reinach. The author enters upon the last part of his inquiry, viz. the representation of animals in primitive art, and the association of the human form with the forms of animals.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 5.—"On the Diurnal Periodicity of Earthquakes." By Charles Davison, M.A.

Reference is made to the previous work of De Montessus and Omori, the former endeavouring to show that the diurnal periodicity of earthquakes is apparent rather than real, and the latter pointing out that a marked diurnal periodicity characterises the after-shocks of great earthquakes in Japan.

The results of twenty-six registers obtained by means of continuously recording instruments in Japan, the Philippine Islands, and Italy are subjected to harmonic analysis with the following conclusions:—

(1) The reality of the diurnal variation of earthquake-frequency seems to be proved by the approximate agreement in epoch (mean local time) of the first four components (24, 12, 8, and 6 hours) for the whole year at Tōkiō and Manila, and for the winter and summer halves of the year at Tōkiō.

(2) In ordinary earthquakes, there is in nearly every case a marked diurnal period, the maximum generally occurring between 10 a.m. and noon. The semi-diurnal period, though less prominent, is also clearly marked, the maximum occurring as a rule between 9 a.m. and noon and between 9 p.m. and midnight. Other minor harmonic components are also occasionally important, the first maximum of the eight-hour component probably occurring about 6.30 a.m., and that of the six-hour component about 3 or 4 a.m.; but for these two epochs the results are not always concordant.

(3) Though the materials are insufficient for any general conclusion, the weaker shocks seem to be subject to a more marked diurnal periodicity.

(4) In the case of after-shocks of great earthquakes, the diurnal periodicity is as a rule strongly pronounced. The maximum of the diurnal period occurs within a few hours after midnight, but the epochs of the other components are subject to wide variation, possibly on account of the short intervals over which the records extend. A special feature of after-shocks is the prominence of the eight-hour and four-hour components.

The epochs of the first four components representing the diurnal variation of seismic frequency are compared in several cases with those for barometric pressure and wind velocity. While the variation of the former cannot be attributed exclusively to either of the latter phenomena, it seems not improbable that the diurnal periodicity of ordinary earthquakes may be due chiefly to that of wind velocity, and the diurnal periodicity of after-shocks chiefly to that of barometric pressure.

Geological Society, February 26.—Dr. Henry Hicks, F.R.S., President, in the chair.—On the structure of the Plesiosaurian skull, by Charles W. Andrews. Owing to the imperfection of the specimens described, various previous accounts of the Plesiosaurian skull were incomplete, and differed from one another in important particulars. There was in the National Collection a fine skull of *Plesiosaurus macrocephalus* which had lately been cleared from the matrix, with a description of which the author was mainly occupied, though other specimens, which were of assistance in clearing up some

difficulties, were also noticed. The author particularly considered the structure of the palate, and only such points in the structure of the rest of the skull as added to or were at variance with previous descriptions were considered.—On certain Granophyres, modified by the incorporation of Gabbro fragments, in Strath (Skye), by Alfred Harker. The rocks described formed a group of irregular intrusions, the largest less than a mile in length, situated in the tract of volcanic agglomerate north and west of Loch Kilchrist. They differed from the normal Granophyres, abundantly developed in the neighbourhood, in being darker, denser, and manifestly richer in the iron-bearing minerals, while in places were seen numerous small rock-fragments evidently of extraneous origin. In the discussion that followed, Sir Archibald Geikie pointed out that the paper had a double value. In the first place, it was important in regard to the local geology of the Western Isles, for it demonstrated by new evidence the posteriority of the Granophyres to the Gabbros; and in the second place, it had a suggestive bearing upon questions of theoretical interest regarding the possible modification of eruptive rocks by the incorporation of foreign material into their substance.—Observations on the geology of the Nile Valley, and on the evidence of the greater volume of that river at a former period, by Prof. E. Hull, F.R.S. The author drew attention to the two great periods of erosion of the Nile Valley, the first during the Miocene period, after the elevation of the Libyan region at the close of Eocene times, and the second during a "pluvial" period extending from late Pliocene times into and including the Pleistocene. In the second part of the paper the terraces of the Nile Valley were described, and full details given of the characters of a second terrace, at a height varying from 50 to 100 feet above the lower one, which is flooded at the present day. This second terrace was traceable at intervals for a distance of between 600 and 700 miles above Cairo. Two old river channels were also described, one at Koru Ombo, and the other at Assuan itself. The author discussed the mode of origin of the second terrace and the old river valleys, and believed them to be due to the former greater volume of the river, and not to subsequent erosion of the valley. He gave further evidence of the existence of meteorological conditions sufficient to give rise to a "pluvial" period, and pointed out that other authors had also considered that the volume of the Nile was greater in former times.—The fauna of the Keisley limestone, part i., by F. R. Cowper Reed. The author had examined a very full series of fossils from the Keisley limestone of Westmoreland, and proposed to describe the fauna of the limestone. In this (first) part of the paper a description of the Trilobites was given.

Zoological Society, March 3.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Mr. G. E. H. Barrett-Hamilton exhibited two skeletons and other bones of the Norway lemming (*Myodes lemmus*), obtained by Dr. H. Gadow from caves in South Portugal. This discovery had increased our knowledge of the distribution of the Norway lemming in past times. In present times the Norway lemming was, roughly speaking, only to be found in Norway and Lapland, its southern range extending to about $58\frac{1}{2}°$ N. lat.; but its remains had been met with in England, and in Quedlinburg in Saxony. Dr. H. Gadow, F.R.S., gave an account of the caves in Southern Portugal in which he had procured these lemmings' bones along with those of other animals.—Mr. Sclater opened a discussion on the rules of zoological nomenclature by reading a paper on the divergences between the rules for naming animals of the German Zoological Society and the Stricklandian code usually followed by British naturalists (see NATURE, March 5, p. 427).—A communication was read, from Graf Hans von Berlepsch and M. J. Stolzmann, on the ornithological researches of M. J. Kalinowsky in Central Peru. The collections made in the years 1890–93 had been transmitted to the Branicky Museum of Warsaw, and contained examples of 295 species and sub-species, of which an account was given in the present paper. Five species and twenty-two sub-species were described as new.—Dr. David Sharp, F.R.S., on behalf of the Committee for investigating the flora and fauna of the West India Islands, communicated a paper on West Indian terrestrial Isopod Crustaceans prepared by M. Adrien Dollfus. The paper contained an account of the Armadilloidian Isopods, of which specimens had been obtained by Mr. H. H. Smith in the islands of Grenada and St. Vincent and the adjacent islets. These were referred to thirteen species, all but one of which were described as new to science.

Entomological Society, March 4.—Mr. Walter F. H. Blandford, Vice-President, in the chair.—Mr. Percy H. Grimshaw exhibited specimens of *Cephenomyia rufibarbis*, Meigen, a new British bot-fly parasitic on the red deer. The specimens were collected in Ross-shire, in June and July 1894, and in the Cairngorm Mountains in 1895.—Mr. C. G. Barrett exhibited, for Mr. Porritt, a black variety of *Polia flavicincta*, taken at sugar in his garden at Huddersfield.—Mr. A. H. Jones exhibited specimens of the butterflies captured at Coomassie by Major Henry P. Northcott during the recent expedition.—Sir John T. D. Llewelyn, Bart., M.P., exhibited specimens of a small species of Diptera which he believed to be parasitic on *Trochilium sphegiforme*, as he had bred a number from that species. He remarked that *T. sphegiforme*, although one of the most local moths in this country, had occurred last year on the estate of Sir J. Hills-Johnes, K.C.B., in Carmarthenshire, in such numbers in the larval state as almost to destroy the whole of the alders growing there. Mr. G. H. Verrall said that the insects belong to a species of *Phora*, possibly *Phora rufipes*, which fed on almost everything.—Mr. Hampson exhibited an exotic species of Locustidæ which Lord Walsingham, F.R.S., had found in his conservatory at Merton Hall, Norfolk.—Dr. Sharp, F.R.S., exhibited specimens of the pupæ of *Micropteryx* (probably *semipurpurella*) and drawings to illustrate their structure. The pupæ were sent to him by Dr. Chapman, who had described their peculiarities in the *Transactions* of the Society in 1893. Dr. Sharp considered the pupa to be that of a Trichopterous insect; most of its structures were those of Trichoptera, and the account given by Dr. Chapman of its emergence showed that this was essentially the same as that of Trichoptera. Mr. McLachlan said that so long ago as 1865 he had suggested the close affinity of *Micropteryx* to the *Trichoptera*. Mr. Hampson, Mr. Barrett, and Mr. Blandford also took part in the discussion which ensued.—Mr. McLachlan exhibited a singular instance of monstrosity in a dragon-fly. The insect was a male of *Hetærina occisa*, Hag., from Venezuela.—Mr. E. E. Green exhibited a larva of an Homopterous insect—one of the *Cicadinæ*—from Ceylon, having what appeared to be a head at its caudal extremity.—M. Louis Péringuey contributed a paper, entitled "Descriptions of New Species of South African Coleoptera, chiefly from Zambesia."—Dr. Sharp read a paper, by Prof. Williston, entitled "On the Diptera of St. Vincent, West Indies. Part I."

Chemical Society, March 5.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read:—The explosion of cyanogen, by H. B. Dixon, E. H. Strange, and E. Graham. When cyanogen, mixed with an equal volume of oxygen, is fired in a long tube, it burns directly to carbonic oxide, and by the use of a photographic method of recording the explosion wave, it is seen that the wave-front is followed by only a very short luminous tail; when a mixture of one volume of cyanogen and two of oxygen is fired, the sharply defined wave-front in which combustion to carbonic oxide occurs, is followed by a long highly luminous tail in which combustion to carbon dioxide occurs.—On the mode of formation of carbon dioxide in the burning of carbon compounds, by H. B. Dixon. The author discusses the various current views respecting the function of water vapour in making a mixture of carbonic oxide and oxygen inflammable; in connection with the dissociation theory of the action, it is shown that the Röntgen rays do not cause the dry mixture to become inflammable.—On the explosion of chlorine peroxide, by H. B. Dixon and J. A. Harker. When cyanogen, acetylene, or carbon disulphide vapour is detonated at one end of a long tube in which it is contained, the explosion wave is not propagated far along the tube; mixtures of chlorine peroxide and oxygen when similarly treated, however, decompose regularly, a true explosion wave being propagated through the gas at about 1100 metres per second.—Note on the use of certain phosphorescent substances in making X-rays visible, by H. Jackson. The most suitable form of vacuum tube for examining the Röntgen rays is one containing a concave aluminium kathode and an inclined platinum anode; the latter spreads the rays from the kathode in all directions, apparently by scattered reflection. A high vacuum is necessary for good results. The most brilliantly phosphorescent substance out of three hundred examined by the author is potassium platinicyanide; it crystallises with $3H_2O$, and since it is most active in its fully hydrated state, should be painted on to black cardboard or vulcanite for use as a screen, in such a way that it can be kept moist. The other

platinicyanides and the platosamine salts are less fluorescent. A study of the discharge phenomena observed during the exhaustion of the tube shows that the rays proceeding from the concave kathode meet at the centre of curvature of the latter, and then diverge in a solid cone; as the vacuum becomes higher, this cone gradually narrows until it becomes at length a straight line. It is interesting to note that this latter would be the behaviour of non-elastic particles emanating normally from the concave kathode.—The union of carbon and hydrogen, by W. A. Bone and D. S. Jordan. On heating carefully purified sugar charcoal to a white heat in hydrogen, 1 to 2 per cent. of the latter is converted into methane. During the burning of an electric arc lamp in hydrogen, acetylene and another hydrocarbon, probably methane, are produced.—Note on the $\alpha\alpha_1$-dimethylglutaric acids, by W. A. Bone and W. H. Perkin, jun.—The symmetrical dimethylsuccinic acids, by W. A. Bone and W. H. Perkin, jun.—The cis- and trans-methylisopropylsuccinic acids, by W. H. Bentley, W. H. Perkin, jun., and J. F. Thorpe. In these three papers the preparation and properties of the acids named are described.

Linnean Society, March 5.—Mr. W. Percy Sladen, Vice-President, in the chair.—On behalf of Capt J. Marriott, Mr. Harting exhibited an antler of the Burmese deer (*Cervus Eldi*), and described a singular condition in another example which for eight years had continued to exude a blood-coloured liquid from a puncture on the under surface of the brow-tine. Prof. Stewart, to whom some of the substance had been submitted for examination, had found no blood-corpuscles therein, and considered it to be grease in a semi-fluid condition, the nature of the colouring matter being as yet undetermined. Mr. Druce thought the substance exuded might be the excretion of the larvæ of some insect feeding upon the internal surface of the horn, and suggested the examination of a section, if possible.—Mr. Harting exhibited a drawing from life of a Klipspringer antelope (*Oreotragus saltator*), lately received (for the first time in this country) at the Zoological Society's Gardens.—Mr. Thomas Christy exhibited several cases of butterflies collected by Mr. Horace Billington in Old Calabar, on which remarks were made by Messrs. W. F. Kirby and H. Druce.—Mr. B. D. Jackson, in directing attention to an English translation by Mr. J. Lucas of that portion of Pehr Kalm's "Travels" which relates to England, remarked that few persons were aware that Kalm, a pupil of Linnæus, had in 1748 spent six months in this country and had diligently noted the plants which he met with. Thus he had recorded no less than sixty plants for Hertfordshire alone, deriving some of his information from an examination of the contents of two haystacks in that county—in this way anticipating by more than a century one of the methods employed by Sir John Lawes and Sir J. H. Gilbert, and by Prof. Fream.—On behalf of Prof. Gustav Gilson, of Louvain, two papers, entitled "Studies in insect morphology," were communicated by Prof. Howes. In the first of these, on segmentally disposed thoracic glands in the larvæ of *Trichoptera*, the author found that in *Limnophilus flavicornis* the prothoracic prominence gives exit to an underlying tubular gland. In *Phryganea grandis* each thoracic sternum gives exit to a glandular apparatus of the same category, the prothorax alone developing a prominence.—In the second paper by Prof. Gilson and M. J. Sadones, on the larval gills of *Odonata*, the authors described in each branchial lamella of *Libellula depressa* three conical processes which are functional in preventing adherence of the lamella to its fellows, and in maintaining full exposure to the surrounding medium.

Mathematical Society, March 12.—Major MacMahon, R.A., F.R.S., President, in the chair.—The President read the following abstract of a paper by Prof. Lloyd Tanner, on the enumeration of groups of totitives. The paper explains a method of determining how many groups of given order can be formed with the totitives of any integer, n. In the investigation use is made of a function formed from a binomial coefficient by replacing each factor, say r, of the numerator or denominator by p^r-1, so that the binomial coefficient is in fact the limiting value of the function as p approaches 1. There are indications of the existence of a reciprocity theorem (viz. that the number of groups of order ν is equal to the number of groups of order $\tau(n)/\nu$), but this theorem is not proved. The attempt to establish the theorem has led to the discovery of some notable properties of the functions—a Van der Monde-theorem, for instance. The functions in question are well known. They were used by Euler as generating functions for the number of partitions, and by Cayley ("Researches on the Partition of Numbers," *Phil. Trans.*, cxlv.). Jacobi in a memoir (*Crelle*, xxxii., 1846), starting with a more general function, obtained a number of formulæ which appear to be different from those used in this paper. Gauss, in the *Summatio serierum quarundam singularium*, used these functions, the base being a complex number of modulus 1. They have been used too (in Schellbach's treatise) as a means of forming the theta-functions. The present application is of a different kind. As in Euler's theory, they are used for enumeration; but the number sought is given by the actual value of the function when the base p is a prime factor of τn.—Prof. Greenhill, F.R.S., next read a paper on the associated dynamics of a Top, and of a Body under no Forces. Jacobi's theorems (*Werke*, ii. p. 480) flow naturally from Darboux's representation by means of the deformable hyperboloid (Despeyrous, *Mécanique*, ii. Note xx.). The hyperboloid is constructed, in Henrici's manner, flattened in the plane of the focal ellipse, by placing the generating lines tangential to the focal ellipse, and knotting together at the points of crossing the generators of opposite systems. Planes are drawn through any point H perpendicular to the generators HP_1, HP_2, through H (the tangents to the focal ellipse through H), the perpendiculars OG, OC are drawn from the centre O upon these planes, and the perpendiculars OY_1, OY_2 on the generators HP_1, HP_2. Then, during the deformation of the hyperboloid, the lengths OG, OC, or HY_1, HY_2 remain constant, and the points Y, T, P in which a generator meets the principal planes are fixed points on the generators; so that the planes through H perpendicular to the generators are tangent planes at H to two fixed coaxial quadrics, the squares of whose semi-axes are numerically equal to the rectangles HY.HV, HY.HT, HY.HP, the sign being taken positive or negative according as Y and V, or T, or P are on the same or opposite sides of H. These quadrics are the momental quadrics of Jacobi's two associated bodies moving under no forces; but as the quadrics are unrestricted in shape, the bodies must be composed of matter which is capable of having a negative density, as is the two-fluid theory of electricity. The curve described by H is a polhode curve common to the two momental quadrics; it is also a line of curvature formed by the intersection of a confocal ellipsoid and a hyperboloid of two sheets; thus any such line of curvature may be taken as a polhode on either of two momental quadrics, the generating lines of the confocal hyperboloid of one sheet through any point being the normals of the quadrics. If OG is held in a vertical position, OC will imitate the associated motion of the axis of a top, if H is moved always in a direction perpendicular to the plane OGC, and OH will represent the resultant angular momentum. If the momental spheroid of the top at the fixed point O is a sphere, then OH will also represent the resultant angular velocity; but in the general case the resultant angular velocity is represented by the vector OI to a point I fixed in the generator HP_2. In constructing *pseudo-elliptic* cases of motion, the ratio of the axes of the focal ellipse is taken as the modulus of the elliptic functions, and the position of P corresponding to a parameter one-nth part of a period will be determined geometrically by means of the poristic relation of a polygon of n or $2n$ sides, circumscribed to the focal ellipse and inscribed in a confocal. The secular term, associated in general with the azimuth, can be cancelled by placing H in the tangent at P_1 in a position given by a simple relation; and now the cone described by OC is algebraical, as also the herpolhode described by H in the plane perpendicular to OG. Thus for Halphen's algebraical herpolhode, P_1 is at Fagnano's point, and H is the mid-point of P_1Y_1. If P_2 is at the end of the minor axis of the focal ellipse, the axis OC of the top describes cusps. If H is placed at Y_2, then OC represents the motion of the thread of a spherical pendulum. After a brief discussion, in which the President and Mr. Love, F.R.S., took part, Prof. Greenhill made a communication on the Catenary on the Paraboloid and Cone. Clebsch's equations for the form of a chain wrapped on a sphere, which is revolving about a vertical axis with sufficient rapidity for the attraction of gravity to be negligible, are here shown to be immediately applicable to the case of a chain on a vertical paraboloid, when gravity is again taken into account. An elliptic integral of the third kind is required, with a pole at the vertex of the paraboloid, and this integral can be compared immediately with the standard form of the pseudo-elliptic integral, by the solution of a certain Jacobian quartic. The arc of the catenary is also directly reducible to the form employed by Abel (*Œuvres*, ii.). The motion of a little ball, rolling on the paraboloid, is re-

ducible to integrals of a similar nature; but in no case does it appear that its path, nor the catenary, can become of a purely algebraical nature. In the catenary on the vertical cone, as well as in the motion of a sphere rolling on the cone, the integrals are more directly reducible to the Jacobian form. In each case the developed catenary or trajectory is the form assumed for a constant central attraction or repulsion.—Lieut.-Colonel Allan Cunningham, R.E., gave a proof that $\frac{1}{4}(5^{11}-1) = 12,207,031$, and $\frac{1}{8}\cdot\frac{1}{23}(7^{11}+1) = 10,746,341$, are both prime numbers.

Royal Meteorological Society, March 18.—Mr. E. Mawley, President, in the chair.—Mr. Frederic Gaster, of the Meteorological Office, delivered a lecture on weather forecasts and storm warnings, how they are prepared and made known, which he illustrated by numerous instruments, diagrams, and lantern slides. Mr. Gaster said that in the preparation of forecasts the position held by the barometer was so much more important than that of any other instrument, that its action must be fully comprehended if the rest of the work was to be at all clearly understood. The lecturer having fully explained this, referred to the use of a single isolated instrument, and showed how new light was thrown on the observer who could have telegraphed to him simultaneous observations from a large number of places scattered over a considerable area of the earth's surface. The kind of variation in the distribution was dealt with, isobars were drawn, and the phenomena which they exhibit in the way of high and low pressure areas described. An explanation was given of the terms "cyclonic" and "anticylonic," and the generally opposite characteristics of these two systems were referred to. Mr. Gaster next drew attention to the obvious importance of the variation in the weather over a given area caused by alterations in the position of the cyclonic and anticyclonic systems, and the importance of the fact that the former tended to move round the latter from left to right. This led to some remarks on the indications observed when disturbances were advancing towards our islands from different points. Attention was drawn to secondary systems, both of high and low pressure, the forms they assume, and their effect on the weather which, but for their presence, would probably have accompanied their primaries; and the necessity for allowing for such systems in sending warnings to our coasts. The lecturer then remarked on the value of auxiliary information, such as is to be obtained from decided changes in the direction of the wind, sudden changes of temperature, the movements of clouds at different levels, observations made at high-level stations, and telegrams from the United States. Mr. Gaster next explained how the information is made known to the public. Forecasts are issued by the Meteorological Office in the *Daily Weather Report*, and also communicated to the press, &c. Hay harvest forecasts are issued to certain selected authorities, who circulate them as much as possible in their neighbourhood. Storm warnings are telegraphed to our coasts with instructions to hoist the cone-point up when the gale is probable from northerly to easterly points, and point down when from southerly to westerly points. In conclusion the lecturer drew attention to the marked improvement which had occurred in these warnings in recent years, and to some of the occurrences which from time to time caused failures.

EDINBURGH.

Royal Society, March 2.—Prof. Geikie in the chair.—A paper was read by Mr. C. A. Fawsitt, on peroxide of hydrogen in reference to its use as an antiseptic. Since its introduction into surgery by Sir Benjamin Richardson, peroxide of hydrogen had not become so popular as was expected. It possessed undeniable advantages—*e.g.* when its oxygen was given off only water remained. But it had the disadvantages of irritability and instability. The former was due to the presence of acids, usually HCl, and solid matter. This was to be avoided by exercising great care in its preparation. The instability of H_2O_2 varied with the method of preparation adopted. Mr. Fawsitt recommended that whenever it was procured, it be diluted to the strength required in practice, and kept in a dark place.—Dr. D. Fraser Harris communicated the results of experiments he had been conducting on some points in the physiological chemistry and coagulation of milk. He found that the small globules, as well as the large, contained fat in direct, and "caseinogen" in indirect proportion to their size. Milk that was heated nearly to boiling point gave the best results with artificial digestion.—Mr. R. C. Mossman read a paper on the seasonal death-rate from certain diseases in Edinburgh during the period 1878-94, with remarks on the relation between weather and mortality. He exhibited the curves of the mortality from various diseases plotted above those denoting temperature, variability of temperature, and rainfall. The most marked result was that bronchitis, pleurisy, and pneumonia, while only very slightly influenced by low temperature, were very directly associated with variability of temperature.

March 16.—Prof. Copeland in the chair.—Mr. J. Y. Buchanan read a paper on the action of water on monochloracetic acid.—Dr. David Hepburn communicated a revised description of the dorsal interosseous muscles of the human hand, with suggestions for a new momenclature of the palmar interosseous muscles, and some observations on the corresponding muscles in the anthropoid apes. The shaft of each metacarpal bone, with the exception of the first, presents two triangular areas, a larger in the dorsal aspect and a smaller in the palmar aspect, neither of which affords origin to muscular fibres. It follows, therefore, that the palmar aspect of the various metacarpal bones are more fully occupied by muscles than the dorsal aspects. The dorsal interosseous muscles, which are abductor in function, are smaller than current descriptions lead us to believe. This is quite in accordance with the comparatively feeble nature of the abductor movements. Each digit is provided with a short flexor muscle presenting radial and ulnar heads, which are capable of acting *independently*, and thereby producing a certain amount of abduction and adduction according to their position with regard to the middle line of the hand. Every muscle of the dorsal or abductor series is inserted in common with *one of the heads* of a short flexor muscle, and in consequence of their close fusion the line of separation between them is somewhat obscured and has been overlooked. The members of the palmar or true adductor stratum have all disappeared from the human hand with the exception of the adductor *Pollicis obliquus et transversus*; hence the action has been thrown upon certain heads of the short flexors, and in consequence these heads stand out more distinctly, especially as their presence is not marked by fusion with any other muscle. Whenever true adductor muscles are found, as in certain of the apes, they are inserted in conjunction with those heads of the short flexors which are capable of supplementing this action. In the case of the human pollex, which possesses the one true adductor muscle, not only is this muscle inserted in common with one head (the ulnar) of the *Flexor brevis pollicis*, but in consequence that that head is always obscured, and in many cases extinguished.—Mr. A. T. Masterman communicated a note on the structure and affinities of Phoronis. He suggested that Phoronis should take its place amongst the Hemichordata, since it showed various points of resemblance to Balanoglossus, to Cephalodiscus, and to Rhabdopleura.—Dr. W. Peddie communicated the second part of a paper on the torsional oscillations of wires. In the first part it was proved that the formula $y^n(x+a) = b$—where y represents the range of oscillation, k represents the number of oscillations which have taken place, and n, a, b are constants—expresses the law of decrease of the oscillations with great accuracy in any one experiment. The value of n is increased by increase of the initial range, and also by fatigue. A theoretical deduction of the formula was also given, it being assumed that the loss of energy per oscillation was proportional to a power of the range. When n is zero the curve changes form and becomes logarithmic. Thus the well-known law for small oscillations is accounted for. In the second part of the paper, additional proof of the great accuracy of the formula is given. The relation $nb = BK^n$ is established between the quantities n and b, B and K being absolute constants. And it is further shown that K is, in terms of the particular angular unit employed, the value of a *critical angle* for the given wire. This critical angle is such that, when the range is equal to it, the loss of energy per oscillation is totally independent of the magnitude of the initial range or of fatigue. When the range exceeds the critical angle, the loss of energy per oscillation is increased by fatigue; when the range is less, the loss of energy is decreased by fatigue. A theoretical explanation of the existence of a critical angle was given. In the particular wire employed, the critical angle corresponds to a twist of about 0·1° pe centimetre of length.

CAMBRIDGE.

Philosophical Society, March 9.—Prof. J. J. Thomson, President in the chair.—Notes on the geological history of Monocotyledons, by Mr. A. C. Seward.—A description of the

skulls found at Girton in 1881, by R. Horton-Smith.—On some scratched stones from the Permo-Carboniferious rocks of South-east Australia and the bearing of the evidence on the question of recurring Ice Ages, by Prof. Hughes. Prof. Hughes exhibited some specimens and photographs given to him by Prof. David of the University of Sydney, pointing out that the glaciation of South Australia as generally understood had been entirely disproved; that there had been no glaciers in the district in question, but that the traces of glaciation were due to ice floating from the south over a subsiding area, with, as he inferred, a compensating elevation elsewhere. He gave a *résumé* of the new evidence which he had collected in favour of the view that the recurrence of local glacial conditions was always connected with movements of elevation and depression, and appealed to physicists to explain the overthrusts and contortions of the surface of the earth, not solely by shrinkage of the nucleus nor by deformation of the whole mass, but by some conditions affecting regions limited in extent and depth, with perhaps a certain amount of periodicity determined by some more general cosmical causes.—On some chipped flints from the higher plateau gravel of Salisbury, by Prof. Hughes. Prof. Hughes criticised the evidence which had been adduced in favour of the discovery of man older than the Palæolithic Age, exhibiting in illustration a collection of so-called Palæotoliths from the plateau gravels near Salisbury, from the stony surface between Six-Mile Bottom and Balsham, and from Kent. As far as he had seen, no satisfactory evidence had been adduced in favour of the higher antiquity assigned, in the case of any of the flints which could be said to bear marks of design.—On the leakage of electricity through dielectrics traversed by Röntgen rays, by Prof. J. J. Thomson and Mr. J. A. McClelland. This paper contains an account of a series of experiments made with the object of investigating the laws regulating the passage of electricity through dielectrics transmitting Röntgen rays. This phenomenon has been discussed by one of the authors in a paper read before the Philosophical Society on January 27, and also in one read before the Royal Society on February 13. The first experiments relate to the rate of leak through different gases under similar conditions as to pressure and potential gradient. The gases used were hydrogen, ammonia, carbonic acid, air, coal gas, sulphuretted hydrogen, chloroform, chlorine, bromine, iodine, sulphur chloride and mercury vapour. Numbers showing the rate of leakage in these gases relatively to that in air are given. In general, though the rule is not without exceptions, the greater the molecular weight of the gas the more rapid the leakage. In hydrogen the leak was slowest, and in mercury vapour fastest; the rate in the vapour of boiling mercury was about twenty-eight times as fast as hydrogen. The rapid rate in mercury vapour is interesting, for this gas offers great opposition to the passage of an ordinary electric discharge. The rate of leak in the halogens is also very rapid, and a tube containing a charged plate in chlorine gas is a very sensitive and convenient method of measuring the intensity of these rays. The rates of leakage in air at different pressures were investigated; it was found that the rate of leak was slower at a low pressure than at a high one, and was over a considerable range of pressure approximately proportional to the square root of the pressure. The effect of temperature was also investigated, and it was found that through air the rate of leak was slower at a very high temperature than at the temperature of the room, but there was an intermediate temperature at which the rate was a maximum. The most remarkable thing about this leakage under the influence of these rays is that the rate is almost independent of the potential difference. Thus when the high potential plate was 5 volts above that of the low, the rate of leak was appreciably greater than when the potential difference was 1 volt, but the rate was no greater when the potential difference was 500 volts than when it was 5. A series of experiments were made to find how the rate of leakage varied with the distance from the bulb; the bulb was placed behind a metal plate with a hole in it: it was found that in the neighbourhood of the phosphorescent glass the reciprocal of the rate of leakage was a linear function of the distance from the phosphorescent patch, but at greater distances it diminished more rapidly than is indicated by this law. The measurements are not inconsistent with the view that the rate varies inversely as the square of the distance from a place in the neighbourhood of the *negative electrode*. Some experiments on the rate of leakage produced by the rays after passing through a varying number of strips of tinfoil seem to indicate that these rays are not all of one kind.

Dublin.

Royal Dublin Society, January 24.—Prof. George F. Fitzgerald, F.R.S., in the chair.—The following papers were read:—On carborundum, a substitute for emery, by Dr. Charles E. Fitzgerald; some remarks on difficulties of meridian circle work, by Mr. Arthur E. Lyster; a method of using common petroleum as the illuminant for beacons and buoys, by which a continuous light for weeks or months may be maintained day and night, without the necessity for the attendance of a light-keeper, by Mr. John R. Wigham At this meeting, Prof. D. J. Cunningham, F.R.S., exhibited and described puppies of the Cape hunting dog (*Lycaon pictus*), preserved in spirit. The animals were born in the Royal Zoological Gardens, Dublin.—Mr. Richard J. Moss described acetylene, the new illuminant.

February 19.—Prof. G. F. Fitzgerald in the chair.—The following two papers were read:—On Hamilton's singular points and planes on Fresnel's wave-surface, by Prof. William Booth, of Hoogley College, Bengal, communicated by Prof. Thomas Preston; on the continuity of transformation from the liquid to the gaseous state, by Prof. Thomas Preston.—There were exhibited at this meeting the Lenard-Röntgen X-rays, and their properties were described by Dr. J. Joly, F.R.S., photographic results being exhibited by Dr. Joly, Mr. W. E. Wilson, and Mr. Richard J. Moss.

Philadelphia.

Academy of Natural Sciences, February 25.—Papers under the following titles were presented for publication: "The Colouring Matter of the Axil of *Celastrus scandens*," by Ida A. Killer; "The Crystallisation of Molybdenite," by Amos P. Brown. The Anthropological Section having precedence, Dr. D. G. Brinton made a communication on the use of the cranio-facial line in determining racial and individual characters on the living subject. The relation of the diameters of the cranium formerly relied on had been found unsatisfactory. He specially recommended a line closely resembling that suggested by the sculptor Charles Rochet. It connects the two auditory foramina, forming a slight curve, the superior border of which connects the internal commissures of the eyes. This line, it is claimed, divides the ideal, normal head into two perfectly equal parts, although in nature, of course, this proportion is not maintained, but varies as a racial character and in individuals. The relations of the lines may also indicate the cranial capacity, as the plane of the curve continued posteriorly is approximately the base of the skull. He further pointed out that the distance between the distal extremities of the curve gives the width of the head and the face; and that a series of curves, described from the fixed points indicated, offers, probably, the simplest and most accurate method of obtaining significant head-measures on the living subject.—Dr. Harrison Allen commented on the difficulty of obtaining satisfactory cranial measurements, and referred to Oldfield Thomas's, taken from the outer margin of the orbits to determine the projection of the nose. He did not think the true horizontal plane of the skull could be fixed. The so-called Frankfurt plane is the one most commonly accepted.—Dr. Seneca Egbert stated that he had demonstrated the action of the X-rays through plates of platinum from ordinary sunlight. Illustrative pictures were exhibited, and the published results of other experimenters were discussed.—Prof. Maxwell Summerville exhibited beautiful specimens of chipped arrow-heads made from common green bottle-glass by the natives of North-western Australia. He also called attention to a stone carved to resemble a miniature grotesque head, from the valley of the Delaware, opposite Milford, and an object used in phallic worship by the natives of Poonah, India.—Dr. D. G. Brinton called attention to the importance of obtaining systematic data for the study of American anthropology, and suggested the wide distribution, under the auspices of the Anthropological Section of the Academy, of circulars of inquiry, similar to those in use by the Committee appointed by the British Association for the Advancement of Science for the study of the ethnography of Great Britain.

March 3.—Messrs. Morris E. Leeds and J. S. Stokes, on behalf of Messrs. Queen and Co., made communications on the historical development of studies in connection with Röntgen photography, presented the most advanced views as to the nature of the X-rays as published by various investigators. They also exhibited a series of fine pictures illustrating the application of the process to the study of biology, and the results obtained by the use of quick and slow plates and various developers. Dr. Egbert having alluded to

the results obtained by him from the direct rays of the sun through platinum plates, Mr. Leeds called attention to the desirability of experimenting with the sun's rays reflected from a mirror. If a positive result be obtained, it would demonstrate either that Röntgen rays can be reflected, or that those producing Dr. Egbert's effects are not Röntgen rays.—Mr. J. Willcox presented a collection of 308 recent and fossil Fulgurs from various localities and geological horizons, illustrating with extraordinary completeness the evolution of the forms.—A preliminary announcement was made of the presentation by Mr. A. Donaldson Smith of fine collections of mammals, birds, reptiles and insects, made by him during his recent exploration of Western Somaliland, Africa.

PARIS.

Academy of Sciences, March 6.—M. A. Cornu in the chair.—The President announced to the Academy the death of M. Sappey, Member of the Section of Anatomy and Zoology.—On the underground pendulum of the Paris Observatory, by M. F. Tisserand. The pendulum is buried to a depth of twenty-seven metres, where its temperature does not vary by more than ·01° to ·02° during the year. Although an attempt was made to keep the pressure of the air round the pendulum constant, the variations in rate were found to follow the variations in the atmospheric pressure.—On a new carbide of zirconium, by MM. H. Moissan and Lengfeld. An account of a second zirconium carbide, ZrC; distinguished from the carbides of allied metals by not reacting with water either at 0° or 100° C.—Actinometric observations made at the Observatory of Montpelier in 1895, by M. A. Crova.—On a log with instantaneous readings, by H. A. Coret.—On the errors in astronomical instruments caused by variations of temperature, by M. Hamy.—On uniform functions defined by the inversion of total differentials, by M. P. Painlevé.—On the principle of an accumulator for light, by M. C. Henry.—On lunar barometric waves and the secular variation of the climate of Paris, by M. P. Garrigou-Lagrange.—Cryoscopic researches, by M. A. Ponsot. Data are given for the limiting values of the molecular lowering of the freezing point of water for ten salts.—On the structure and constitution of the alloys of copper and zinc, by M. G. Charpy.—On the *rôle* of alumina in the composition of glass, by M. L. Appert. The introduction of alumina into glass tends to prevent devitrification, and allows of a considerable quantity of lime to be present.—The constitution of rhodinol, by MM. P. Barbier and L. Souveault. From a study of its oxidation products rhodinol is shown to be a primary unsaturated alcohol.—Explanation of the cruciferous flower from its anatomy, by M. O. Lignier.—On the geological constitution of the strata in the vicinity of Heraclea (Asia Minor), by M. H. Douville.—On a meteorite that fell near Fisher (Minnesota) on April 9, 1894, by M. N. H. Winchell. This meteorite consists chiefly of olivine and enstatite, together with small quantities of iron, troïlite, tridymite, and maskelynite.—On the meteor of February 10, 1896 (Madrid), by M. Miguel Merino.—On a meteor represented by Raphaël in his "Madone de Foligno," by M. P. Masson.—A confirmation of the results of M. Le Bon on dark light, by M. Ellinger.—On some experiments demonstrating the action of the Röntgen rays on fluorescent bodies, by M. G. Campos.—On a point in the kinetic theory of gases, by M. Chapel.

BERLIN.

Meteorological Society, February 4.—Prof. Börnstein, President, in the chair.—Prof. Zuntz spoke on mountain-sickness, and gave an account of the experiments on respiration he had carried out, in conjunction with Dr. Schumburg, at great altitudes on Monte Rosa. He found that when resting the consumption of oxygen was greater than at lower levels, but not very markedly so, and differed with different individuals. During work, which consisted in climbing a steep incline, the amount of oxygen consumed was per kilogramme-metre of work nearly three times as great, indicating a correspondingly increased expenditure of energy. In accordance with the above, the so-called mountain-sickness cannot be due chiefly, if at all, to the diminished partial pressure of oxygen at the higher level. He considered that it is rather the outcome of a lessened cardiac activity brought about by the powerful stimuli of insolation acting on the eyes and skin, by the action of cold, of increased air-currents, and of psychical excitement united to the antecedent fatigue. The deleterious effects of these abnormal stimulations can be lessened, or even done away with, by practice; and the effect of the diminished partial pressure of oxygen, which is observed in the case of some persons, may be prevented by mixing a little (about 2 per cent.) carbon dioxide with the inspired air, since this gas induces somewhat deeper inspirations.

Physiological Society, February 7.—Prof. Zuntz, President, in the chair.—Prof. Goldstein exhibited a series of photographs taken with Röntgen X-rays.—Dr. Abelsdorff spoke on the visual purple of fishes, which shows a maximum in its absorption spectrum differing from that in the similar spectrum obtained from amphibia, birds and mammals. He exhibited a solution of visual purple obtained from fish; it was at first of an obvious violet colour, became speedily yellow under the action of light, and then finally and very slowly colourless. By treating fish-eyes with alcohol and formalin he had obtained preparations which showed the retina of a brilliant purple colour as looked at anteriorly.—Dr. Benda spoke on the regeneration of blood corpuscles in man, and on the structure of the organs therein concerned, as based on serial sections through lymphatic nodules, the spleen, and the marrow of bones. He came to the conclusion that in the nodules the germinal centre, the germinal layer, and the more peripherally placed leucocytes form part of one developmental series. He found similar structures in the spleen, and also that in the marrow of bones the red corpuscles exhibit a similar series.

February 21.—Prof. du Bois Reymond, President, in the chair.—Dr. Frenzel exhibited photographs taken on bromide of silver-paper with Röntgen X-rays. Of these the most interesting was that of a frog taken on twelve sheets of the paper laid one upon the other; the photograph came out equally well defined on each sheet.—Dr. Schulz spoke on the influence of temperature on the working-power of unstriated muscles. He had studied the isotonic and isometric contractions of strips from the muscular layer of a frog's stomach in response to maximal electrical stimuli at temperatures between − 6° and + 45° C. From the temperature of the room onwards the height of circulation increased up to 35°, the tension up to 32°, while at the same time, and up to the same temperatures, the latent period and duration of the contraction diminished. Above these maxima all the phenomena were exactly reversed. At 45° the muscles gave no further reaction, and a temperature of 60° to 65° caused a permanent shortening. On cooling below the temperature of the room, both the height of contraction and the tension diminished progressively, whereas the latent period and duration of contraction increased down to a lower limit of − 5° to − 6° C., at which temperature there was no further reaction. When slowly rewarmed contractions again made their appearance. Between − 8° and − 10° the muscle contracted suddenly and permanently; but this contraction disappeared on slow warming, the muscle now being inert even at higher temperatures. Comparing the striated with the unstriated muscles, Dr. Schulz laid stress on the fact that with a rise of temperature the latter exhibit a gradually increasing efficiency up to the maximal, whereas the former, according to Gad and Heymans, show a secondary minimum at 19°.

Physical Society, February 14.—Prof. du Bois Reymond, President, in the chair.—Prof. Börnstein exhibited photographs of a hand taken directly on to paper by means of Röntgen X-rays.—Prof. von Bezold spoke on balloon voyages from their scientific point of view. Starting with the fundamental physical principles which underlie the events taking place in cyclones and anticyclones as also in the general atmospheric circulation, he proceeded to show the necessity for more exact measurements of temperature and humidity in the upper strata of the air, and of ascertaining the height at which air passes over from a cyclone into an anticyclone. In conclusion, he gave the values of this height as far as they have so far been determined by means of balloon ascents made from Berlin.—Prof. Neesen exhibited specimens of the photographic effects he had obtained by means of kathode rays which were reflected by means of a mirror in the vacuum tube into a lateral tube, and then passed out of the tube through an animal membrane. It was found that a thin glass plate materially weakened the action of the rays, whereas they passed just as readily through the animal membrane as do the Röntgen rays through the fleshy parts of the hand. Prof. Goldstein stated that the Röntgen rays may be concentrated, and hence sharply-defined images obtained, by using as kathode an aluminium disc backed with a glass plate, and nearly filling the vacuum tube.

—Dr. Koehne announced that he had succeeded in obtaining an electrolytic solution of carbon. Using pure carbon as anode, hot sulphuric acid as electrolyte, and platinum as kathode, he observed that the fluid became yellow and then dark brown or black, while at the same time a thin layer of graphite was deposited on the kathode. By means of carbon, hot sulphuric acid, and peroxide of lead, he obtained a galvanic cell, with a resistance of 100 ohms, which gave a current of one volt.

February 28.—Prof. du Bois Reymond, President, in the chair.—Dr. Martens spoke on the magnetisation of horizontal discs rotating in the terrestrial field, and made of various samples of iron, steel, and nickel, explaining how he had measured their magnetism by means of an astatic needle, and giving the values he had obtained.—Mr. Goode exhibited a vacuum tube for the production of Röntgen rays, on to which a system of bulbs and tubes had been fused and partially filled with mercury, so as to admit of the removal of any gases which had collected in the tube.—Mr. H. Starke explained a simple method of determining the electrical constants of solid bodies. It is based on the introduction into one arm of a Wheatstone bridge of a condenser between whose plates fluid mixtures of various dielectrics with varying electrical constants can be placed, and on the finding of a mixture such that when the given solid is immersed in it the constants of the mixture are not altered.—Prof. Lampe exhibited a series of Röntgen photographs taken by Prof. König in Frankfurt a-M., which were remarkable for their sharpness and the shortness of the exposure necessary for their production.—Prof. Rubens demonstrated Hertzian vibrations whose wave-length was 4½ cm., and which, after being made parallel by means of a glass lens, were then polarised by the use of a set of three glass discs.

NEW SOUTH WALES.

Linnean Society, November 27, 1895.—Mr. Henry Deane, President, in the chair.—On some developments of the mammalian prenasal cartilage, by R. Broom.—On a small fossil diprotodont marsupial, with large grooved premolars, by R. Broom. A more complete description from more perfect specimens of the little fossil marsupial described under the name *Burramys parvus* at the June meeting.—On a small fossil *Petaurus*-like marsupial, by R. Broom. Under the provisional name *Palæopetaurus elegans* was described a small fossil marsupial from a bone-breccia deposit in the neighbourhood of Taralga.—On the organ of Jacobson in an Australian bat (*Miniopterus*), by R. Broom.—Observations on a gravid echidna, by R. Broom.—Stray notes on Papuan ethnology, by C. Hedley. An interesting carved figure-head, of the bird and crocodile design, "geroma," from a village in Bentley Bay, British New Guinea, was described. It was interesting as setting at rest the identity of the bird, a cassowary, which Prof. Haddon had in his monograph been unable to determine. He also described an ingenious palm-leaf basket "porha" in common use among the natives of Eastern British New Guinea.—On an undescribed structure in the leaves of certain plants, by Alex. G. Hamilton. In this paper was given a detailed account, with figures, of certain structures which have been found to be present in the leaves of more than thirty species of plants referable to various natural orders, respecting which the text-books and other literature available, beyond an incidental allusion or two, seem to furnish little or no satisfactory information. In their most complete form the structures in question appear as hair-lined cavities in the leaf substance, situated in the axils of the primary or secondary veins, and opening to the exterior on the under-surface of the leaf by a small opening with a thickened rim (as in *Pennantia Cunninghamii*, Miers, and *Coprosma lucida*. Experimental evidence was adduced against the view that they are catchment hollows for water; and the author was led to think that they were structures once useful, but now no longer functional, and in course of disappearing.—Preliminary note on the occurrence of a placental connection in the bandicoot (*Perameles obesula*); and on the fœtal membranes of certain macropids, by Jas. P. Hill.—Notes on the eucalypts of New South Wales (No. 1), by Henry Deane and J. H. Maiden. The authors having for a considerable period made a special study of the eucalypts of this colony, both in the field and from dried specimens, gave the results of a series of observations in regard to the botanical structure, geographical distribution, &c., of a number of species belonging to the *Renantheræ*.—Descriptions of some new Australian plants, by J. H. Maiden and R. T. Baker.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Glaciers of the Alps: J. Tyndall, new edition (Longmans).—Proceedings of the London Mathematical Society, Vol. xxvi. (Hodgson).—The Hymenoptera Aculeata of the British Islands: E. Saunders (L. Reeve).—Moorland Idylls: Grant Allen (Chatto).—The Whence and Whither of Man: Prof. J. M. Tylor (New York, Scribner).—Statesman's Year-Book, 1896 (Macmillan).—Single-Salt Analysis: B. P. Lascelles (Sonnenschein).—Geschichte der Explosivstoffe: S. J. von Romocki. II. Die Rauchschwachen Pulver (Berlin, Oppenheim).—Fear: A. Mosso, translated by E. Lough and F. Kiesow (Longmans).—Historical and Future Eclipses: Rev. S. J. Johnson, new edition (Parker).—Elements of the Theory of Functions of a Complex Variable: Dr. H. Durège, translated by Drs. Fisher and Schwatt (Philadelphia, Fisher).—Ostwald's Klassiker der Exakten Wissenschaften, Nrs 72, 73, 74, 75 (Leipzig, Engelmann).—Lehrbuch der Anatomie des Menschen: Prof. C. Gegenbaur, 2 Vols. Sechste Verbesserte Auflage (Leipzig, Engelmann).—From the North Pole to Equator: A. E. Brehm, translated (Blackie).—Elementary Practical Chemistry: G. S. Newth (Longmans).—Researches on Mimicry on a Basis of a Natural Classification of the Papilionidae: Dr. E. Haase, translated by Dr. C. M. Child, Part 2 (Stuttgart, Nägele).—Atlas of Nerve Cells: Drs. Starr, Strong, and Leaming (Macmillan).—Handbook of Jamaica for 1896 (Stanford).—Calcul du Temps de Pose en Photographie: H. Boursault (Paris, Gauthier-Villars).—Géométrie Descriptive: A. Gouilly (Paris, Gauthier-Villars).—A Fauna of the Moray Basin: J. A. Harvie-Brown and T. E. Buckley (Edinburgh, Douglas).

PAMPHLETS.—Report for 1895 on the Lancashire Sea-Fisheries Laboratory at University College, Liverpool (Liverpool).—Démonstration de l'Axiome XI. d'Euclide: M. Frolov (Paris, Michelet).—Royal Gardens, Kew. Hand-list of Conifera grown in the Royal Gardens (Eyre).—Typhoon Highways in the Far East. No. 1. Across the South End of Formosa Strait (Zi-Ka-Wei).—On the Application of the Law of Similarity to Marine Propellers: J. D. Young (Newcastle-on-Tyne).—The San Jose Scale: L. O. Howard and C. L. Marlatt (Washington).—Observations Météorologiques, Magnétiques et Hydrométriques de l'ile de Danemark dans le Scoresby Sound, 1891–92 (Copenhague).

SERIALS.—Zeitschrift für Wissenschaftliche Zoologie, lxi. Band, 2 Heft (Williams).—Académie des Sciences de l'Empereur François Joseph I. Bulletin International Classe des Sciences Mathématiques et Naturelles, II. (Prague).—American Journal of Science, March (New Haven).—Journal of the Western Society of Engineers, January, and Supplement (Chicago).—Journal of the Institution of Electrical Engineers, March (Spon).—Journal of the Franklin Institute, March (Philadelphia).—Psychological Review, March (Macmillan).—Transactions of the Astronomical and Physical Society of Toronto, 1895 (Toronto).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1896, No. 2 (Bruxelles).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. x. No. 1 (Manchester).—Astrophysical Journal, March (Wesley).—Royal Natural History, Part 29 (Warne).—L'Anthropologie, tome vii. No. 1 (Paris, Masson).—Economic Journal, March (Macmillan).—Timehri, December (Stanford).—Imperial University, College of Agriculture Bulletin, Vol. ii. No. 5 (Tōkyō).—Himmel und Erde, March (Berlin, Paetel).—Trans. R. S. Edin., Vol. xxxviii. Part 2 (No. 9): Specific Gravities and Oceanic Circulation: Dr. A. Buchan (Williams).—American Naturalist, March (Philadelphia).—Journal of the Anthropological Institute, February (Paul).—Das Tierreich, Probe-Liefg., Heliozoa: Dr. F. Schaudinn (Berlin, Friedländer).—Physical Review, Vol. iii. No. 5 (Macmillan).

CONTENTS. PAGE

THURSDAY, APRIL 2, 1896.

THE HISTORY AND MANUFACTURE OF EXPLOSIVES.

Geschichte der Explosivstoffe. Von S. J. von Romocki. Two parts, pp. 394 and 324. (Berlin: Robert Oppenheim, 1895, 1896.)

The Manufacture of Explosives. By Oscar Guttmann, A.M.I.C.E., F.I.C. Two volumes, pp. 348 and 444. (London: Whittaker and Co., 1895.)

THE first part of the first of these two works is a most curious compilation, drawn from all sources, of historical matter connected with the manufacture and different uses of explosives. The author appears to have spared no trouble in hunting up old documents and engravings illustrating the different engines of war, which have depended on villainous saltpetre for part, at least, of their destructive attributes. These engravings are extremely quaint, and give one a good idea of the state of mediæval art as applied to printing; that shown on pp. 288–289 ("Verteidigung eines Engpasses mit Landtorpedos") depicts a most theatrical ambuscade in which the "special artist" has surpassed himself, and the enemy thoroughly deserve the destruction which has overtaken them. Naturally most of the text is German, but there is also a large amount of French and Latin intermixed, here and there, with a little Greek and Arabic, or even Chinese, and one can only regret that the exigencies of modern life prevent most people from acquiring even a very superficial knowledge of the numerous and varied tongues with which the gifted author appears to possess so great a familiarity.

In part ii. the author continues the narrative in dealing with the various natures of ordinary and the more modern descriptions of gunpowder, and includes much interesting matter relating to the production of chlorates, nitrates and picrates, and to the history of the discovery of guncotton by Schönbein, as well as of the subsequent prolonged attempts in Austria to utilise it in guns as a smokeless propellant. These attempts proved futile, and ended finally in the idea being abandoned, though not before several accidents had taken place. The manufacture of the several explosives is dealt with to some extent, but apparently simply with a view to including them in the historical records of the various patents which covered their invention.

As an interesting statement of historical facts connected with gunpowder, these volumes leave little to be desired; but the reader will find no new data regarding the results, ballistic or chemical, of the new powders, nor are the given results of the older powders so complete as to render the work really valuable to the student.

Mr. Oscar Guttmann's work on explosives is of quite a different type, and makes no pretence whatever to dilettanteism; on the contrary, everything is described in an eminently practical way, with the intention of interesting only those who are concerned in the manufacture or use of explosives. To the military and to civilians the work is strongly recommended, as it is practically the only trustworthy one on the manufacture of modern explosives in the English language, and as it consists of a most careful and extensive selection of the experience gathered by manufacturers of explosive material, or of the allied substances necessary in the manufacture of explosives.

The historical prelude, which has now become an inseparable portion of all technical works, is brought within reasonable limits and occupies about 22 pages, of which 17 are employed on speculations regarding the origin of gunpowder; but no very convincing conclusions are arrived at, except that, perhaps, the honour of the invention of guns—not gunpowder—belongs to Berthold Schwarz, a Freiburg monk. In England it is our conceit to consider Roger Bacon, also a monk, as the inventor of gunpowder. This, however, is very problematical, but the curious fact remains that the clerical profession have always taken a deep interest in the improvement of engines for the destruction of human life; we may instance the two monks aforesaid—without mentioning the many bishops who, in mediæval times, themselves wielded the mace on the battle-field; then we have the inventor of percussion-caps and more lately we have two clergymen, each distinguished as the inventor of a ballistic instrument, and to one of whom the art of gunnery owes a deep debt of gratitude.

The preparation of the prime materials are dealt with mostly in volume i., and include the more important substances necessary in the production of ordinary black powder, and, what is far more interesting, of the new smokeless powders. The production of glycerine and nitric acid are fully dealt with; but for sulphuric acid the author modestly refers the reader to Lunge's work. The preparation of charcoal is treated exhaustively, with the exception of that particular variety used in the manufacture of brown powder, the exact treatment of which is kept a secret; and it may be for the same reason that brown powder itself is not dealt with. This is, however, of small moment, as the use of ordinary gunpowder, of both black and brown varieties, is becoming very restricted as propellants, and even in mining operations black powder is being gradually ousted in favour of the so-called flameless explosives.

The important point of blending is dealt with only so far as this operation is performed by mechanical means—*i.e.* for small grain powders; but in the manufacture of prismatic powders, slight variations of density are unavoidable in different batches of prisms, and blending by hand has to be resorted to. Similarly with smokeless powders, it is found that different lots of cotton give rise to some slight variations in the guncotton produced, which, although of a trifling nature, are quite sufficient to affect the ballistics of the resulting powder; so that such powders as cordite or ballistite in sticks or tubes require to be hand-blended.

Volume ii. is a most interesting and valuable addition to the literature on explosives: the manufacture of nitrocellulose—both the true guncotton and collodion-cotton varieties—is described fairly completely, and, although apparently so simple, there are certain difficulties of an economical nature in connection with the production of collodion-cotton having a definite degree of nitration. The production of nitro-glycerine receives the attention

which this dangerous substance deserves, and manufacturers and users of it will find much valuable information regarding precautionary measures in dealing with this explosive or with the dynamites, of which it forms practically the only explosive ingredient. But neither guncotton nor dynamite would be of much service without the detonator, which consists of a copper capsule filled with that curious substance, fulminate of mercury. The production of this material is briefly described, and an attempt is made to elucidate its chemical constitution; the subsequent charging of caps and detonators is dealt with at greater length. In connection with the late terrible explosion of dynamite at Johannesburg, it is stated that the detonators and dynamite were carried in the same railway truck; and if this really were so, no surer means of producing an "accidental" explosion could have been devised.

Users of the so-called safety explosives—ammonite, bellite, &c.—will be interested in tracing the preparation of the different ingredients, the principal of which is generally one of the nitro-compounds of benzene.

The subject of smokeless powders is treated well, and the different machines used are illustrated in such a manner as to show their general construction and essential parts. The manufacture of cordite, as carried out at the Government factory at Waltham Abbey, is one of the most interesting, inasmuch as it is the powder adopted by the War Office for use in rifles and in guns of all calibres. The procedure is, however, somewhat varied in private factories, as, for instance, the cordite paste, instead of being mixed by hand, is sometimes mixed more or less mechanically under water, and in consequence handling the paste is to a large extent dispensed with. Handling substances containing nitro-glycerine for the first time frequently produce most distressing symptoms, due to the absorption of the nitro-glycerine by the skin, the operator being seized with violent headache, or often with vomiting; these symptoms, however, rapidly disappear in the course of a day or two. The complexion of those employed is much improved, and on this account there is a great competition for employment among the young women of the district, it being considered a sure road to matrimony.

The last portion of the work is devoted, more or less, to the description of the apparatus used in the examination of explosives; some of the instruments belonging, let us hope, to a bygone age, are of the most crude description, but there are included some of the more refined instruments employed at the present time. Very little, indeed, is said about the results obtained from ordinary powder, or from the modern explosives; and to those who are interested in the new powders as propelling agents, the question of the energy that can be developed by them, and the conditions under which such energy can be efficiently and satisfactorily utilised, is of the highest importance. So far as we know, the most complete and extensive series of experiments on this subject, and on certain kindred researches, has been made in this country principally at Elswick, and some interesting results have been obtained.

Should a new edition of the work be called for, no doubt some of the debatable points would receive revision: and we would also recommend the author not to make the same indiscriminate use of the Centigrade and Fahrenheit thermometric scales which appears in the present edition; both volumes, however, show very conclusively the large amount of engineering skill Mr. Guttmann has brought to bear in their production.

H.

ENTOMOLOGY AND EVOLUTION.

Handbuch der paläarktischen Gross-Schmetterlinge für Forscher und Sammler. Von Dr. M. Standfuss. Pp. xii + 392; eight plates. (Jena: Gustav Fischer, 1896.)

IT has long been recognised that the class of insects is particularly rich in good material for the elucidation of many important biological problems; and in the hands of Bates, Wallace, Meldola, Poulton, Merrifield, Fritz Müller, Weismann and others both in this country and abroad, to say nothing of Darwin himself, the lepidoptera, and especially the butterflies, have been largely turned to account in elaborating the details of the picture of organic evolution. Notwithstanding all that has been done both by way of observation and experiment in this direction, it can hardly be questioned that the author of the book before us is right in asserting that the work of systematic entomologists has not been made so profitable to science as it might have been; and that entomological literature has hitherto been overlooked, with some justice, by scientific zoologists. In re-editing with large additions his former useful "Handbuch für Sammler der europäischen Gross-Schmetterlinge," Dr. Standfuss has proposed to himself the laudable aim of raising the "Cinderella of the Sciences" to a position more worthy of her intrinsic merit; and his method of so doing is to combine a full account of his own experiments and speculations on various points of biological interest with the practical directions of a manual for collectors. The result is the substantial volume before us, which the author hopes will serve as a stimulus to the "mere collector" to direct some of his energies into channels which may lead to really important scientific results. There can be no doubt that Dr. Standfuss has thrown himself into his task with great vigour and enthusiasm. The experiments recorded in this book were conducted on a very large scale, and must have laid a severe tax on the industry and perseverance of their originator. Any one with experience in this direction will have some idea of what is involved in the rearing of more than 7000 lepidopterous larvæ through their various stages, under varying conditions, and in keeping full records of the results. Whether the ordinary collector will be stirred into emulation of these achievements is perhaps doubtful, but Dr. Standfuss has certainly done his best to show him how much interest may attach to the study of butterflies and moths when conducted with a definite scientific object.

The practical part of the book needs little comment. It treats of the usual topics to be found in works of the kind in a plain and serviceable manner. The advice given is sound and sensible, and bears evidence of being the fruit of the author's own experience. We note that

the diseases of larvæ and pupæ are dealt with at greater length than is often the case in similar manuals. With regard to the section on the care of a collection, our own opinion would be in favour of considerably amplifying the suggestions here thrown out as to labelling and register-keeping.

It is, however, to the experimental and speculative part of the work that the scientific reader will turn with most interest. Here he will find a large mass of valuable material; consisting in the chief place of elaborate records of the author's own experiments. The first subjects dealt with are those of hybridisation, the respective influence of the male and female parent on the structure and appearance of the hybrid progeny, the fertility of crosses, the production or suppression of intermediate forms. The value of well-planned and systematic experiments on these points cannot be easily overestimated. The importance of the subject has been fully recognised by Darwin, Wallace, Galton and Weismann amongst others, but the comparative absence of quantitative results such as Dr. Standfuss gives us, and the consequent impossibility of applying any measurement to the forces at work, has hitherto prevented the facts of hybridisation, their relation to fertility, and their bearing on questions of heredity and species-formation, from having their due weight in the discussion of biological problems. Another large and most interesting group of experiments centres round the question of the effect of abnormal external conditions, during the immature stages, upon the form of the perfect insect. The author has here taken as his model the well-known temperature experiments of Dorfmeister, Weismann and W. H. Edwards upon lepidopterous pupæ, elaborating the conditions and extending his investigations over a wider range of material. It is remarkable that the species selected by him as the subjects of experiment were in very many cases the same as those used by Merrifield, who had already been working quite independently on similar lines, and most of whose results, published before those of our author saw the light, are in close agreement with the latter. The work of each experimenter thus receives independent confirmation from that of the other

While there can be no question of the remarkable interest attaching to the effects obtained by these temperature-experiments upon pupæ, and while it will be generally allowed that much gratitude is due to Dr. Standfuss for his assiduity in conducting and recording the large number of experiments here referred to, and in accurately describing their results, there will be much difference of opinion as to the value of his interpretations. Dr. Standfuss's own views on the subject of evolution may be shortly stated. He believes in the hereditary transmissibility of acquired characters; and without enunciating any definite theory of the nature of pangenesis, he argues in favour of a centripetal mode of germ-formation. Variations are, according to him, produced by the direct effect of the environment on the parent organism, and the principle of natural selection is limited in operation, many species having become established without its aid. The theory of mimicry, he thinks, has certainly to be reckoned with, but great caution must be used in applying it to the explanation of any given case. Of Fritz Müller's development of the mimicry theory, in consideration of which many of his objections would lose their force, he takes no notice. From all this it may be seen that our author is a pronounced Neo-Lamarckian Space would not allow us to follow him in all his speculative arguments, which, though often far-fetched and sometimes demonstrably erroneous, are always ingenious and interesting. Recognising the extreme value of facts in reference to such a question as that of the true nature of heredity, we have carefully searched the whole volume for any unequivocal instance of the genuine transmission of an acquired character, and we are bound to say that we have not found one, unless n the sense admitted by Weismann ("The Germ-Plasm," 1893, p. 401), which, strictly speaking, is not a matter of heredity at all. The author has evidently convinced himself that several of his results are to be interpreted in the former, viz. the Lamarckian way. For our own part, we can only say that they seem to us to be all capable of other explanations; and that in spite of the difficulty he alleges (p. 292), the only means of attempting a satisfactory solution of this question, as it appears to us, would be a careful experimental inquiry pursued through several generations. For this purpose some species should be sought for which is at the same time capable of partial domestication, and possesses distinctive features of colour and pattern which are fairly sensitive to external influences. An argument against Dr. Standfuss's view of species-formation is afforded by the curious reversionary character of many of the changes produced by exposure of the pupa to abnormal conditions of temperature. The ancestral features thus revived are sometimes of so very distinct and special a kind, that it seems scarcely adequate to regard them, as he does, simply as the direct effect of temperature conditions similar to those under which the ancestral form came into existence. But our author practically ignores the possible influence of sexual selection and of the necessity for recognition in the production of characteristic external markings, and with him "adaptation" as applied to these markings means little else than protective resemblance. Hence, probably, his limited view of the action of natural selection, and his readiness to attribute the distinct aspects of the various species of *Vanessa* and other groups to direct climatic influences, *plus* isolation. Still, whatever may be the omissions and shortcomings of the book from the theoretical point of view, of which much more could be said, its value as a great quarry of facts is undeniable, and the author makes no attempt to present his experimental results in any but the most fair and impartial manner.

The value of the descriptions is greatly increased by the excellent plates, which are very well executed and really illustrative of the text. The book is well printed; we have only discovered a very few misprints in the text, and one small inaccuracy in one of the plates. The want of a general index is a serious drawback. Taking the work as a whole, we are bound to say that it is one that challenges the serious attention of biologists, and that whatever may be thought of the author's speculations and arguments, the facts that he has collected are of unquestionable interest and importance.

F. A. DIXEY.

A PHILOSOPHY OF MAN.

Die Schöpfung des Menschen und seiner Ideale. Ein Versuch zur Versöhnung Zwischen Religion und Wissenschaft. Von Dr. Wilhelm Haacke. Mit 62 Abbildungen im Text. Pp. x + 487. (Williams and Norgate, 1895.)

An author who claims for his book that it is, "in its aim and substance, entirely new and original," does not prepossess a reader in his favour; nor do the contents of Dr. Haacke's book remove the prejudice. He seeks to prove that the mechanical conception of nature leaves room for faith in a moral order of nature, by showing that natural bodies and organisms, and human ideals alike follow a great law of tendency to equilibrium. The book is popular in character, and it has the merit of being very readable. It is partly and mainly biological, partly philosophical, and throughout speculative. Dr. Haacke will have nothing to do with Darwin or Prof. Weismann—not merely that he rejects pangenesis or the continuity of the germ-plasm, but natural selection as well. He substitutes an epigenetic theory of *gemmæ* or crystals of the germ-plasm, which have polarity and are united into a *gemmarium* (or collection of *gemmæ*) whose configuration seems to be determined by every influence which affects the organism. The theory, which is explained in full in the author's work "Gestaltung und Vererbung," is based on the assumed transmission of acquired characters. How unclearly he conceives the problem is shown by his description of an ideal test of that transmission (p. 344), which is no test at all, and by the confused treatment of inherited memory. Dr. Haacke thinks that in consequence of the organic connection of every part of the body, acquired characters may affec the configuration of the gemmarium, but he does no explain how the male gemmarium, when it passes rom the parent body, should retain this configuration. The philosophical portion of the book is purely hypothetical. Each atom has sensation, and therefore, according to the sensori-motor law, also motion, which it exhibits in the tendency to equilibrium with other atoms. Schopenhauer's "will to live" is replaced by the "will to equilibrate." It is not clear whether the author supposes each brain-cell to have consciousness (which is psychological atomism with a vengeance). The most interesting portion of the book, from a philosophical point of view, is the slight sketch in which it is shown that art, morality, and religion exhibit the tendency to unite various elements into an equilibrium, that is, in simpler language, into an organic system. It is not, however, quite original, nor is it adequate. The author hopes to reconcile religion with the materialistic conception of nature in half a page, in which he declares the ideal of religion to be the equilibrium of all other ideals, and God to reveal himself everywhere as the tendency to equilibrium. From a purely speculative point of view, the author's doctrine is open to a grave objection. That every organic form which can maintain itself exhibits internal equilibrium is undoubted, and if Dr. Haacke had expounded this truth in its application to morality and knowledge with anything approaching adequacy, he might have done service. But it is quite another thing to assume a "tendency to equilibrium." How much truer is the simple doctrine of Spinoza, that everything tends to "persist in its being"—*in suo esse perseverare*—a real tendency of which equilibrium is the result. Such a view is perfectly compatible with natural selection, which is the process by which bodies that cannot be in equilibrium under their conditions are eliminated. But Dr. Haacke apparently takes natural selection to be a force instead of a mere process according to which forces act, dismisses it for this reason, and sets up in its place an unreal striving after equilibrium, which equilibrium is only an effect. Of his purely philosophical quality the sample which the author gives in the concluding portion of his book does not induce us to recommend the book to the study of philosophers.

OUR BOOK SHELF.

Roads and Pavements in France. By A. P. Rockwell, A.M., Ph.B. Pp. 107. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

The title of this book is hardly broad enough to do justice to the contents, which include general descriptions of construction and maintenance of roads, and of other points to be considered when building a new road or improving one already built. At the same time, all who have to do with road-making know that they can learn something from an account of the methods adopted by the highly-educated and able engineers whose work has resulted in the excellent roads of France to-day, and whose experience as to the best and most economical systems extend over more than a hundred years. The author has brought together the results of this instructive experience, and has thereby produced a work which will be of great service to road contractors and engineers in every country.

Single-Salt Analysis. By B. P. Lascelles, M.A. (London: Swan Sonnenschein and Co., Ltd., 1896.)

This addition to the already too numerous sets of tables for use in chemical laboratories, consists of fourteen cards containing instructions what to look for, and what to conclude, when conducting the various operations involved in the analysis of a simple salt. Five cards are devoted to stating dry tests, and the remainder are taken up with wet tests for a simple salt, soluble in water or acids. The cards will be useful in elementary chemical laboratories, where test-tubing is the order of the day; but we hope for a time when their use will be limited to students who intend to become analysts, for work conducted upon the lines laid down in these and similar analytical tables are of no educational value whatever.

The West Indies and the Spanish Main. By James Rodway. Pp. xxiv + 371. 48 illustrations. (London: Fisher Unwin, 1896.)

The stirring events described in this latest addition to the "Story of the Nations" series are sufficient to furnish material upon which a score of romances might be built, even though Marryat, Kingsley, Stevenson, and other writers innumerable have made the Indies the arena of all the incidents attractive to adventurous spirits. So full of incident is the history of the West Indian Islands, that Mr. Rodway has had a difficulty in compressing his story within reasonable limits, and he has only been able to do so by giving preference to facts referring to the islands as a whole, and omitting events of interest chiefly to the communities of particular islands and provinces. Little is said about the islands from the scientific point of view, but as a contribution to historical geography the book is undoubtedly valuable; for few persons are better acquainted with the history of the progress and development of the Indies than the author.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Velocity of Propagation of Electrostatic Force.

As we may have to wait some time for the experimental solution of Lord Kelvin's very instructive and suggestive problem concerning two pairs of spheres charged with electricity (see NATURE of February 6, p. 316), it may be interesting to see what the solution would be from the standpoint of existing electrical theories.

In applying Maxwell's theory to the problem, it will be convenient to suppose the dimensions of both pairs of spheres very small in comparison with the unit of length, and the distance between the two pairs very great in comparison with the same unit. These conditions, which greatly simplify the equations which represent the phenomena, will hardly be regarded as affecting the essential nature of the question proposed.

Let us first consider what would happen on the discharge of (A, B), if the system (c, d) were absent.

Let m_0 be the initial value of the *moment* of the charge of the system (A, B), (this term being used in a sense analogous to that in which we speak of the *moment* of a magnet), and m the value of the moment at any instant. If we set

$$m = \mathrm{F}(t), \quad \ldots \ldots \ldots \ldots \quad (1)$$

and suppose the discharge to commence when $t = 0$, and to be completed when $t = h$, we shall have

$$\mathrm{F}(t) = m_0 \qquad \text{when} \qquad t < 0, \quad \ldots \quad (2)$$

and

$$\mathrm{F}(t) = 0 \qquad \text{when} \qquad t > h, \quad \ldots \quad (3)$$

Let us set the origin of coordinates at the centre of the system (A, B), and the axis of χ in the direction of the centre of the positively charged sphere. A unit vector in this direction we shall call i, and the vector from the origin to the point considered ρ. At any point outside of a sphere of unit radius about the origin, the electrical displacement ($\mathfrak{D}$) is given by the vector equation

$$4\pi\mathfrak{D} = [3r^{-5}\mathrm{F}(t - cr) + 3cr^{-4}\mathrm{F}'(t - cr) + c^2r^{-3}\mathrm{F}''(t - cr)]\chi\rho$$
$$-[r^{-3}\mathrm{F}(t - cr) + cr^{-2}\mathrm{F}'(t - cr) + c^2r^{-1}\mathrm{F}''(t - cr)]i, \quad . \ (4)$$

where F denotes the function determined by equation (1), F′ and F″ its derivatives, and c the ratio of the electrostatic and electromagnetic units of electricity, or the reciprocal of the velocity of light. For this satisfies the general equation

$$-\nabla^2\mathfrak{D} = c^2d^2\mathfrak{D}/dt^2, \quad \ldots \ldots \ldots \quad (5)$$

as well as the so-called "equation of continuity," and also satisfies the special conditions that when $t < 0$

$$4\pi\mathfrak{D} = m_0(3r^{-5}\chi\rho - r^{-3}i)$$

outside of the unit sphere, and that at any time at the surface of this sphere

$$4\pi\mathfrak{D} = m(3\chi\rho - i),$$

if we consider the terms containing the factor c as negligible, when not compensated by large values of r. That equation (4) satisfies the general conditions is easily verified, if we set

$$u = r^{-1}\,\mathrm{F}(t - cr), \quad \ldots \ldots \ldots \quad (6)$$

and observe that

$$-\nabla^2 u = c^2d^2u/dt^2, \quad \ldots \ldots \ldots \quad (7)$$

and that the three components of $\mathfrak{D}$ are given by the equations

$$\left.\begin{aligned} 4\pi f &= -d^2u/dy^2 - d^2u/dz^2 \quad \ldots \\ 4\pi g &= d^2u/dxdy \quad \ldots \ldots \ldots \\ 4\pi h &= d^2u/dxdz \quad \ldots \ldots \ldots \end{aligned}\right\} (8)$$

Equation (4) shows that the changes of the electrical displacement are represented by three systems of spherical waves, of forms determined by the rapidity of the discharge of the system (A, B), which expand with the velocity of light with amplitudes diminishing as r^{-3}, r^{-2}, and r^{-1}, respectively. Outside of these waves, the electrical displacement is unchanged, inside of them it is zero.

If we write (with Maxwell) $-d\mathfrak{A}/dt$ for the force of electrodynamic induction at any point, and suppose its rectangular components calculated from those of $-d^2\mathfrak{D}/dt^2$ by the formula used in calculating the potential of a mass from its density, we shall have by Poisson's theorem

$$\nabla^2(d\mathfrak{A}/dt) = 4\pi d^2\mathfrak{D}/dt^2,$$

or by (5),

$$\nabla^2(d\mathfrak{A}/dt) = -4\pi c^{-2}\nabla^2\mathfrak{D},$$

whence

$$d\mathfrak{A}/dt = -4\pi c^{-2}\mathfrak{D} \quad \ldots \ldots \ldots \quad (9)$$

From this, with (4), and the general equation

$$d\mathfrak{A}/dt + 4\pi c^{-2}\mathfrak{D} + \nabla\mathrm{V} = 0,$$

we see that during the discharge of the system (A, B) the electrostatic force $-\nabla\mathrm{V}$ vanishes throughout all space, while its place is taken by a precisely equal electrodynamic force $-d\mathfrak{A}/dt$.

This electrodynamic force remains unchanged at every point until the passage of the waves, after which the electrostatic force, the electrodynamic force, and the displacement, have the permanent value zero.

If we write *Curl* for the differentiating vector operator which Maxwell calls by that name, equations (8) may be put in the form

$$4\pi\mathfrak{D} = \text{Curl Curl }(iu),$$

whence

$$d\mathfrak{D}/dt = (4\pi)^{-1}\text{ Curl Curl }(idu/dt).$$

From $d\mathfrak{D}/dt$ we may calculate the magnetic induction $\mathfrak{B}$ by an operation which is the inverse of $(4\pi)^{-1}$ Curl. We have therefore

$$\mathfrak{B} = \text{Curl }(idu/dt),$$

or

$$\mathfrak{B} = [r^{-3}\mathrm{F}'(t - cr) + cr^{-2}\mathrm{F}''(t - cr)](yk - zj).$$

The magnetic induction is therefore zero except in the waves.

Equations (4) and (9) give the value of $d\mathfrak{A}/dt$ as function of (t and r). By integration, we may find the value of $\mathfrak{A}$, Maxwell's "vector potential." This will be of the form of the second member of (4) multipled by $-c^{-2}$, if we should give each F one accent less, and for an unaccented F should write $\mathrm{F}_{\prime}$, to denote the primitive of F which vanishes for the argument ∞.

That which seems most worthy of notice is that although simultaneously with the discharge of the system (A, B) the values of what we call the electric potential, the electrodynamic force of induction, and the "vector potential," are changed throughout all space, this does not appear connected with any physical change outside of the waves, which advance with the velocity of light.

If we now suppose that there is a second pair of charged spheres (c, d), as in the original problem, the discharge of this pair will evidently occur when the relaxation of electrical displacement reaches it. The time between the discharges is, therefore, by Maxwell's theory, the time required for light to pass from one pair to the other.

It may also be interesting to observe that in the axis of χ, on both sides of the origin, $\chi\rho = r^2i$, and equation (4) reduces to

$$4\pi\mathfrak{D} = [2r^{-3}\mathrm{F}(t - cr) + 2cr^{-2}\mathrm{F}'(t - cr)]i.$$

Here, therefore, the oscillations are normal to the wave-surfaces. This might seem to imply that plane waves of normal oscillations may be propagated, since we are accustomed to regard a part of an infinite sphere as equivalent to a part of an infinite plane. Of course, such a result would be contrary to Maxwell's theory. The paradox is explained if we consider that the parts of the wave-motion, expressed by F and F′, diminish more rapidly than those expressed by F″, so that it is unsafe to take the displacements in the axis of χ as approximately representing those at a moderate distance from it. In fact, if we consider the displacements not merely in the axis of χ, but within a cylinder about that axis, and follow the waves to an infinite distance from the origin, we find no approximation to what is usually meant by plane waves with normal oscillations.

J. WILLARD GIBBS.

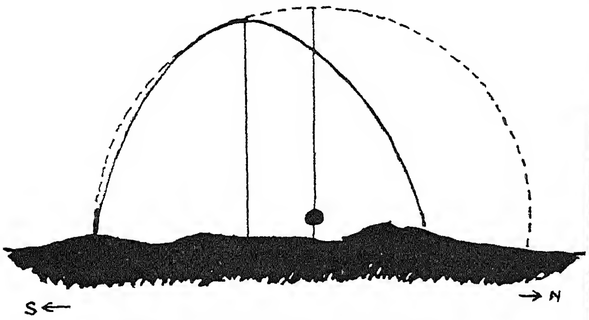
New Haven, Conn., March 12.

An Unusual Solar-Halo.

ON March 17, at Göttingen, a curious solar halo was observed by a friend and myself towards the time of sunset. The weather that day had been beautifully fine, but towards 5h. p.m. (Mean European Time) thin light clouds began to form, which covered the heavens with a thin white raiment. When the sun was

about a few degrees from the horizon (the horizon at the place of observation was not the true one, for a large but not very distant hill intervenes towards the west), there seemed to be suddenly formed a halo of peculiar shape. Its form may be described as nearly, if not quite, parabolic, the axis of the parabola being vertical. Curiously enough, this parabolic form was not symmetrical with regard to the position of the sun, but the latter was situated some distance to the north of the axis. The above phenomenon was observed at about 5h. 50m.–5h. 55m. p.m.

A few minutes afterwards (6h. 5m.), this parobolic form slowly underwent a change, and after a minute or two a circular



Halo at sunset, February 17, 1896, Göttingen.

halo concentric about the sun was distinctly visible. While the concentric halo was in the act of being formed, that portion of the parabolic halo towards the south seemed to maintain its position, but the northern end moved distinctly more north until the position of the sun was half-way between the two. The parabolic form *may* have been caused by the positions of the light fleecy clouds, apparently distorting the halo on the northern side and making the whole appear parabolic; but the change of shape was so considerable, that this explanation seems hardly satisfactory. WILLIAM J. S. LOCKYER.

Remarkable Sounds.

MR. GODWIN-AUSTEN'S letter in NATURE of January 16, reminds me of similar sounds heard at Java in the year 1881. I was then building a railway tunnel through the Gunung Kendang, a range of hills about 100 metres high, situated between the towns of Sukabumi and Tjiandjor, Preanger Regencies, a district where more seismic disturbances take place than in almost any other district of Java.

One morning at about six o'clock, when at breakfast, I was startled by a very loud detonation which made me fear that one of our small vertical boilers at the other side of the works had exploded. I at once sent a man over the hill to ask for information, and received a note from my European assistant stating that no accident had taken place, but that he also heard the detonation and took it for an accidental explosion of some cases of dynamite at Tjiperda, a kampong about six miles from the tunnel, the headquarters of one of the European railway contractors. He at once went thither to see whether any assistance might be wanted, but found that nothing unusual had happened. The contractor, however, told him that at the very moment that we had heard the detonation he had felt a very severe vertical shock of earthquake, but had heard no sound.

In this same tunnel I experienced twice a very severe horizontal shock of earthquake which made a creaking sound in the timbering from end to end in the adits, causing some of the horizontal timbers which had not yet been spiked to fall down. The first time that this happened the coolies bolted, but the second time I managed to keep them in the works to watch the timbering. TH. DELPRAT.

Malang, Java, February 18.

An Excellent View of the Retinal Circulation.

ON a cycling tour recently, after riding some forty miles, with much hill-climbing and against a strong wind, I lay down on a grassy bank facing the east, towards sunset. Viewing the clear eastern sky, I obtained a most remarkable view of my own retinal circulation. A companion also got an excellent view of his own blood corpuscles. The apparent circulation occupied a considerable portion of the visual field, and a most vivid conception was obtained of the relative slowness of movement in the capillaries. It occurred to me afterwards that the reason of the phenomenon was the hyperæsthesia of the retina, caused by the dilatation of the arterioles, which is a characteristic of excessive cycling. It would be interesting to learn whether others have obtained similar experiences. JAMES W. BARRETT.

Melbourne, Australia.

Butterflies and Hybernation.

SOME time late in last autumn, a tortoiseshell butterfly took refuge in a small bath-room in this house, established itself on the ceiling, and there remained, immovable, throughout the winter. On the 10th of this month it shifted its position, and on the 12th flew out of the open window. On the 19th, and again to-day, I have seen a tortoiseshell butterfly fluttering about the garden, and should not be surprised if this early rover were the same individual as that which has undoubtedly wintered here. Half a dozen gauzy-winged green flies also hybernated in close company with the butterfly, but they woke up and flew a fortnight or so before the tortoiseshell butterfly stirred. DAN. PIDGEON.

The Long House, Letherhead, March 24.

Children's Drawings.

AS supplementary to the interesting note in NATURE of February 20, on children's drawings, I may mention that some children of my acquaintance show what seems a strong native tendency to reverse right and left in drawing such letters as L and J, making them ⅃ and ⅂. It is possible this confusion is akin to that confusion of right and left which one first feels on using a mirror for toilet purposes, as shaving, &c.

Lake Forest, Illinois, March 16. HIRAM M. STANLEY.

"Testacella haliotidea."

ON addressing you some time ago on the subject of Worcestershire being a habitat of what I regard as this mollusc, some of your contributors applied for specimens. I have now six to give away. One of your contributors doubted whether the specimen I then had was Haliotidea, on account of alleged rarity. The same doubt applies now.

Worcester Museum, March 23. J. LLOYD BOZWARD.

An Early Swarm of Bees.

A SWARM of bees on March 23 is, I think, so unusual, that you may perhaps like to be informed that one was taken here yesterday. A. PAGE.

Tendring, Essex, March 24.

THE MANAGEMENT AND PROTECTION OF FORESTS.[1]

I.

PROF. SCHLICH'S important work is approaching completion. The two first volumes were noticed in December 1889 and July 1891.[2] Of these, it is understood, a new edition will soon be necessary. The third volume, which deals with forest management, is about to appear in a Spanish translation. Vol. iv. is an English adaptation of an excellent German book on forest protection, by Dr. Richard Hess, Professor of Forestry at the University of Giessen. It is the work of Mr. Fisher, formerly Conservator of Forests and Director of the Imperial Forest School at Dèhra Dùn in North-Western India. The last volume will deal with forest utilisation. In the present article, we propose to deal with the subjects of the third and fourth volumes, viz. the management and the protection of forests.

[1] "A Manual of Forestry," by William Schlich, C.I.E., Ph.D. Vol. iii. (pp. xix + 397). "Forest Management," by William Schlich. Vol. iv. (pp. xix + 593). "Forest Protection," by W. R. Fisher, B.A. (London: Bradbury, Agnew, and Co., 1895.)

[2] NATURE, vol. xli. p. 121; vol. xliv. p. 265.

The management of forests depends upon the objects which the proprietor desires to realise. These objects may be of two kinds: they are either indirect, such as landscape beauty, protection against erosion, landslips, avalanches; or they are direct, the production of timber or other forest produce, so as to yield the largest possible permanent income to the proprietor. Dr. Schlich deals with the attainment of the direct objects, that is, with the economic working of forests; but he justly observes, that a forest under good economic management, as a rule, is capable of yielding all those indirect advantages that may reasonably be expected from it.

As explained on a previous occasion, Dr. Schlich's manual is, in the first instance, intended for the instruction of students preparing for the Indian Forest Service at Coopers Hill College. At the same time, there seems good ground for hoping that eventually it may also be useful to proprietors, land-agents, and wood-managers in Great Britain, as well as in the Colonies and the United States of North America. The third volume of the manual has a special value for persons interested in the management of woodlands in Great Britain; it is the first really comprehensive work upon this subject that has been published in English, and those who may take the trouble to work through its pages, will find that it will enable them to strike out a new line in the management of their woodlands. In 1883, another Indian forest officer, who had received his professional education in Germany, Mr. J. L. Laird MacGregor, now Conservator of Forests in the Bombay Presidency, attempted to place portions of the subject before English readers, under the title "Organisation and Valuation of Forests." (London: Wyman and Sons.)

At the outset, it will be necessary clearly to understand what the author intends by the term "forest management." Forestry, like medicine, engineering, or agriculture, originally commenced as an empirical routine; but its operations are now built upon the results obtained by researches in numerous branches of pure science. The most important of these are mathematics, botany, zoology, chemistry, geology, law, and political economy. Apart from these auxiliary sciences, forestry proper deals with the following subjects: (1) the raising and maintenance of woods, or sylviculture; (2) the protection of forests against damage; (3) the utilisation of forest produce; (4) forest management; (5) forest law.

The last-named subject has been dealt with in a separate work,[1] which, though not published as part of Dr. Schlich's manual, essentially belongs to this series of forest publications. The author, Mr. B. H. Baden-Powell, in 1868 was Small Cause Court Judge at Lahore, and consented to be employed during a series of years in the Indian Forest Service, then a small and humble concern, the progress of which was not generally regarded with favour. The main object of this measure was to secure his assistance in the matter of forest legislation. After doing excellent work as Conservator of Forests in the Punjab, and as Inspector General of Forests to the Government of India, Mr. Baden-Powell resumed his judicial work, and closed his Indian career as Judge in the Chief Court of the Punjab.

The first volume of Dr. Schlich's manual is introductory, the second deals with sylviculture, the third with forest management, the fourth with forest protection, while the fifth will teach utilisation of forest produce. Forest management is built upon the other branches, and under a strictly logical arrangement it ought to be the last volume of the series. This, however, would have delayed its publication. It may be objected that the term "forest management" has a wider meaning in English than that attributed to it by Dr. Schlich, that it comprises all operations of forestry, including sylviculture protection and utilisation of forest produce. In his manual the author uses it in a somewhat restricted sense, but this restriction is justified; it is convenient, and cannot lead to misconception. In French this branch of forestry is called *aménagement des forêts*, in German the usual term is *Forsteinrichtung*. MacGregor, in the work quoted, designates a portion of it as *Forest Organisation*. The term selected by Dr. Schlich seems the most suitable.

Forest management, as here understood, comprises three main subjects: mensuration, valuation, and working plans. Forest mensuration deals with the instruments used, the measurement of timber, standing and felled, it determines the volume of entire woods, the age of trees and woods, as well as the increment of woods. It appears necessary here to draw attention to another technical term, which, though English, is used in a definite sense. Dr. Schlich employs the term "wood" to designate what in German is called *Bestand*, meaning part of a forest forming a unit of fairly the same description. It might be objected that a "wood" is generally understood to mean an isolated small forest block, surrounded by clearings or by prominent natural boundaries. It will be a great convenience if Dr. Schlich's use of the term "wood" is accepted. The volume of a wood standing, say, on one acre of ground, is the product of two factors, the number of trees per acre and the mean volume of those trees. Again, the volume of a tree is the cylinder, height × sectional area, multiplied by a coefficient, called the form factor, which is different for each species, and in each species varies according to age and size of the tree. By a most elaborate system of measurements of many hundred thousand trees of all ages grown in different localities, form factors have now been established in Germany for most of the principal species. These form factors are governed by laws peculiar to each species. Thus, for trees 50 and 100 feet high of Scotch pine and Beech, the following factors are used to calculate the volume of timber down to three inches diameter:

	50 ft.	100 ft.
Scotch Pine	0·48	0·45
Beech	0·40	0·51

It must be distinctly understood that these form factors are only applicable to forests managed upon proper economic principles, where the trees, while young, are allowed to grow up crowded in compact masses, so as to form straight well-shaped stems, free from knots and branches, and are afterwards thinned out methodically, with the object of leaving in the final crop only well-shaped sound trees, likely to yield the most valuable timber. To trees grown in open park-like woods, these form factors would not be applicable.

Hand in hand with the determination of form factors, yield tables have been prepared in Germany for the principal species. These yield tables give the volume of timber in completely stocked woods of the different species standing on a given area at different ages, and in localities of the different quality classes. The work of examining the data, upon which these yield tables have been based, has led to an important result, viz. that the mean height of a wood as a rule indicates the quality of the locality. On good soil and under conditions otherwise favourable, the mean height of a wood is much greater than one of the same age which has grown up under less favourable conditions. Indeed, it is possible, with the help of yield tables to ascertain the volume of an even aged wood, the age of which is known, by determining the mean height of the trees composing it. The following extract from the yield table for Scotch pine in Germany, mainly taken from the figures given by Dr. Schlich, may serve to explain this.

[1] "Forest Law," by B. H. Baden-Powell, C.I.E., late of the Bengal Civil Service. (London: Bradbury, Agnew, and Co., 1893.)

Volume and Volume-increment of Timber down to 3 inches diam. Net value and Value-increment. All on one Acre, stocked with Scotch Pine of middling quality.

Age, years	60	70	80	90	100
Number of trees per acre ...	516	393	316	266	230
Mean height, feet	51	57	63	67	71
Volume, cubic feet, solid ...	3713	4183	4587	4902	5158
Current annual increment, cubic feet, solid	47·0	40·4	31·5	25·6	
Volume increment, per cent.	1·2	0·93	0·60	0·51	
Net value of stock (shillings)	1186	1683	2225	2789	3376
Volume- and value-increment, per cent.	3·76	2·83	2·29	1·93	

If two woods, known to be 60 and 100 years old, have a mean height of 51 and 71 feet respectively, it follows that they belong to the class, of which an extract is here given, which is known as the third or middling class, and, if completely stocked, the volume standing on one acre would be 3713 cubic feet in the one, and 5158 cubic feet in the other case. Other Scotch pine woods of the same age, if their mean height were greater, would belong to a higher quality class, and if fully stocked, their volume would be that recorded in the yield tables under their class. It stands to reason that in woods not fully stocked the timber per acre is less in inverse proportion to the degree of completeness.

The great practical importance of height-growth will perhaps be better understood by reference to matters which, many years ago, have exercised considerable influence upon the development of regular forest management in India. The writer of these lines, on taking charge, in January 1856, of the Pegu teak forests, made it his first duty to ascertain which were the most valuable forest tracts in that country. The number of teak trees of the different age classes on the square mile, he ascertained by a system of linear valuation surveys, laid through the forests in all directions. At the same time he measured the height of trees in all districts. The data thus obtained, the timber standing on the ground, and the height of the trees, particularly of the younger classes, enabled him to classify the forests, and to pick out those which were the most valuable. The measures which he had introduced, had gained him the confidence and goodwill of the Karen and other inhabitants of the forests, for those measures gave to the people profitable employment in timber operations, and this made them allies, instead of enemies, in regard to forest protection. The merchants of Rangoon, on the other hand, naturally desired to get the forests into their own hands, and, backed by the influence of the powerful mercantile firms of Calcutta, they induced the Government of India to order the Pegu forests to be thrown open to private enterprise. These orders had to be carried out; but, fortunately, they did not require that the whole of the forests should be thrown open at once. Those districts, therefore, in which the growing stock of teak timber, in regard to height and otherwise, was most promising, were for a time retained under control of the Forest Department, while the rest were thrown open to private enterprise, in accordance with the orders received. This was in 1861. Subsequently a different view of the question was taken by Government; the arrangements which had been made could not, however, be cancelled. The mischief had been done; but, fortunately, it had been limited to the less valuable districts. The really valuable forests, which had been reserved in 1861, had been saved, and this made it possible to maintain a profitable system of regular management.

The little table, entered on page 511, illustrates the growth of a Scotch pine wood of middling quality between the ages of sixty and a hundred years. As the wood advances in age, the number of trees diminishes, but the remaining trees are taller and heavier, and hence the total volume increases. During these 40 years no less than 286 trees have died or been thinned out, and the skill of the forester consists in this, that the final crop is composed of sound and well-shaped trees, so that their timber may fetch the highest price obtainable. These figures show further, that, while in the first period of 10 years, between 60 and 70, the timber produced per acre amounted to 470 cubic feet, or 47 cubic feet a year, only 256 cubic feet, or 25·6 cubic feet annually, were produced from the 90th to the 100th year.

The current annual increment is greatest while the forest is young, in the case of Scotch pine between the ages of 30 and 40, after which it diminishes steadily. The annual increment may be regarded as a percentage of the growing forest capital. Between the years 60 and 70 the increment per cent. (p) would be determined by the formula: $4183 = 3713 \times 1{\cdot}0p^{10}$, which makes $p = 1{\cdot}2$. Between the years 90 and 100 the increment per cent. is only 0·51. The maintenance of a forest, which increases at a rate so slow and so steadily diminishing, at first sight appears to be a most unprofitable undertaking. Fortunately the market value of the timber up to a certain point increases with the age of the wood. The net value of the growing stock (less the cost of cutting, carriage, and other expenses) of the wood exhibited in the table at the age of 60 years is 1186 shillings, rising to 1683 shillings at the age of 70. During this period the value- and volume-increment per cent. is 3·76, but it falls steadily to 1·93 per cent. between the years 90 and 100. Obviously, from a purely financial point of view, it is best to cut the wood when it is between 80 and 90 years old, and to invest the proceeds in Consols at 2½ per cent., for its maintenance beyond that age entails a loss of interest. The increment, that is the interest on the growing capital of the forest, is less than can otherwise be obtained on perfect security.

It is also evident that the value- and volume-increment per cent. may be used to aid in determining the most profitable rotation to adopt in the management of a forest. In the vicinity of coal- or other large mines, where pit-props find a ready sale, a rotation between 60 and 70 years, and even lower, would be most profitable. Where, however, the chief demand is for building timber, or there is a risk lest an over-production of smaller wood might lower prices, the rotation should be higher, 70 to 80 or 80 to 100 years. The value- and volume-increment per cent. does not, however, correctly express the rate at which the forest capital works. For this purpose the formula must be completed by inserting the annual expenses for taxes, administration, &c., as well as the rent of the soil. The result is called the *forest per cent.* To discuss this part of the subject would, however, lead too far on the present occasion.

Part ii. deals with forest valuation. Obviously it is often necessary, when a forest is to be divided, or assessed or sold, to determine its capital value. The English reader may be disposed to think this an extremely simple matter. The value of a piece of property is either its selling value or its productive value, and these can readily be ascertained by the prices paid for forest land in the open market, or by the rent derived from forest land. Sales of forest land, however, do not often occur, and when a sale takes place, the price realised for one piece of forest does not give the value of another piece. Soil, aspect, elevation, and the other factors which influence the annual timber production and the rate at which the timber can be sold, must be considered, and more than these, the actual condition of the growing stock depending upon species, age, and previous treatment.

Nor does the rental of forests come to our aid; forest lands, as a matter of fact, are not often leased out, the difficulty being to make sure that the capital value of a forest has been maintained unimpaired during the lease. The rent obtainable from a field, or from a piece of grass-

land, whether let as a sheep-walk or for shooting, is known or can readily be ascertained. The same holds good in the case of osier-beds, which are cut over annually or every second year, and, in the case of coppice woods, which are worked on a short rotation. In all these cases the yield is approximately the same every year, and so is the annual outlay for labour and manure. Matters are complicated where standards are held over in the coppice, and more complicated in the case of high forest. A piece of high forest consists of trees which require eighty or hundred years, or even longer, to come to maturity. It consists of woods of all ages, and in the same wood trees of different species and of different ages are often found mixed. Under good management, a piece of high forest, if of sufficient extent, ought to yield, year after year, approximately the same quantity of timber, and hence a forest under a good system of management, in accordance with a well-considered working plan, is analogous to a field or meadow. When this, however, is not the case, it obviously is not a simple operation to determine the annual yield and the capital value of a forest. The annual yield is derived, in the shape of thinnings and final cuttings, from certain compartments this year, and from other compartments another year. Data extending over a long series of years would be needed to ascertain its average amount.

It may be objected that the capital value of a forest consists of two items, the value of the land and the value of the growing stock; that the former can generally be estimated within narrow limits, and that the latter should be calculated by adding up the market value of the timber standing in each compartment. This method, however, would leave out of account all young woods, which do not yet contain marketable timber; it would, in fact, treat them as blanks. The result of such a proceeding would be misleading, for obviously the capital value of a forest depends upon the yield which may in future be expected from it. And the future yield depends quite as much upon the condition of the young woods, which eventually are to furnish thinnings and the final crop, as upon the timber which at the present time happens to be marketable.

On the assumption that a forest is worked in accordance with a system settled beforehand, its capital value and its rental can obviously be calculated with the aid of yield tables. All net income, that is, the amounts expected to be realised by the sale of timber, less the cost of cutting, carriage, and other expenses, is discounted to the present time, and from the present value of all income is deducted the present net value of all expenses expected to be incurred upon the property. The result thus obtained is called the expectation value. Starting from an area not stocked, the *soil expectation value* is obtained. Thus, on the assumption that Scotch pine is to be planted, the soil expectation value of an acre of land of middling quality, such as that to which the data given on page 512 relate, will be as follows:—

Under a rotation of		With a net rental of
60 years	196*s*.	4·90*s*.
70 ,,	236*s*.	5·91*s*.
80 ,,	250*s*.	6·25*s*.
90 ,,	245*s*.	6·14*s*.
100 ,,	229*s*.	5·73*s*.

In calculating these values, the question had to be settled which rate of interest should be employed. As regards security, forest property has the drawback of possible damage by fire, storms, snowbreak, and insects. On the other hand, once placed under systematic management, a forest yields approximately equal returns annually, while those of fields and grass-lands vary according to the seasons. Once established, a forest requires less labour, and can be left alone for a time without much risk, for the timber continues to grow all the same. Lastly, the yield of several years may be anticipated, if money is wanted, or if it is desired to take advantage of a temporary rise in timber prices. These are substantial advantages of forest property, which make it a desirable investment, and therefore justify a low rate of interest. In these calculations, as well as in all others in this portion of his manual, the author has employed the interest of British Consols, that is, 2½ per cent. The calculation of the soil expectation value will be understood at a glance by stating the formula for a rotation of 80 years:

$$S_e = \frac{Y_{80} + T_{30}\cdot 1{\cdot}025^{50} + \ldots + T_{70}\cdot 1{\cdot}025^{10} - c\ 1{\cdot}025^{80}}{1{\cdot}025^{80} - 1} - \frac{e}{0{\cdot}025}$$

Y_{80}, the final yield at the end of the rotation is, according to the table given, worth 2225 shillings; the thinnings at the ages of 30, 40, 50, 60 and 70 years are worth $T_{30}=4$, $T_{40}=36$, $T_{50}=67$, $T_{60}=86$, $T_{70}=91$ shillings. These values are all prolonged to the end of the rotation, and the same is done with c, the cost of formation, here assumed to amount to 60 shillings, which is deducted from the sum of final and intermediate yields. The difference is the rent yielded by the forest every 80 years, that is, at the end of each rotation, and the present value $\frac{r}{1{\cdot}0p^{80}-1}$ of this perpetual rent, after deducting the capital value of c, the annual expenses for administration, taxes, &c., ($e=3s.$), represents the soil expectation value.

All other data remaining the same, the value of S_e varies with the length of the rotation adopted, and in the present case its value culminates for a rotation of 80 years. Obviously this is financially the most profitable rotation which yields the highest net rental, 6·25 shillings per acre. Under this rotation the capital value of the growing stock is utilised to its full extent; if the wood is allowed to grow older, both soil expectation value and net rental diminish. It will be understood that on the data here assumed, it will pay to plant Scotch pine on land of middling quality, if that land can be purchased at 250 shillings (£12 10*s*.), or less, an acre.

The method here explained can be employed to determine the expectation value, not only of land, on the assumption that it is to be planted up with Scotch pine or other trees, but also of existing forests. The expectation value of a normal forest, for instance, consisting of 80 compartments of one acre each, all of the same middling quality, completely stocked with Scotch pine, in a regular succession of ages, the wood on the youngest compartment being 1, that on the oldest 80 years old, would stand as follows:—

	£		£	*s*.	*d*.
Growing stock ...	3418	or, per acre ...	42	14	6
Soil	1000	,, ...	12	10	0
	4418	,, ...	55	4	6

It must be distinctly understood that these calculations are based upon assumptions, which may not in all cases be realised. The first assumption is that the plan adopted, upon which the formula is based, will be strictly carried out, that thinnings and other operations will not be interfered with by fires, storms, snowbreak, insects, or other damage, and that the areas will always be fully stocked with even aged timber. The second is, that the data of the yield tables will actually hold good in the case in point. The third assumption is, that the prices realised by sale of the timber, that wages and other circumstances which govern the value of c and e, will be, and remain, as entered in the calculations.

There is some analogy with engineering formulæ. These the practical engineer uses as his guide, not blindly, but with circumspection and with due consideration of all circumstances which may affect the result. The difference is this, that the forester attempts to express by a mathematical formula the growth of trees,

of organised beings, the development of which is governed by a multitude of influences, varying incessantly. Nevertheless, if used with due caution, these mathematical formulæ, elaborated with praiseworthy perseverance by foresters in Germany, will be found most useful aids in considering the difficult problems which forestry presents in all countries. Some of these problems can, others cannot, in the present state of our knowledge, be solved by the use of mathematical formulæ. Space forbids a further discussion of this subject.

In the kingdom of Saxony the State owns a forest area of 430,000 acres, which, after deducting all expenses, yields a mean annual net revenue of £390,000, or 18*s.* per acre. For many years it has been an established practice to determine, at intervals of ten years, the capital value of each forest range, soil and growing stock, and to calculate the rate of interest which, under existing management, that capital yields. The total area consists of 107 forest ranges or executive charges, and authentic statements, giving the financial result of forest management in each range, are published annually. During the five years ending with 1892 the average capital value of the entire area (soil and growing stock) amounted to 15 millions, or about £36 an acre. During this period, therefore, these forests have yielded interest on the capital involved at the rate of 2·6 per cent. Many of the 107 forest ranges have yielded less than 2 per cent., but a large number regularly yield more than 3 per cent. Compared with the State forests in other countries of Germany, those of Saxony have great advantages. The country is densely inhabited, up to the edge of the forests, factories and other industrial establishments are numerous, and there is a complete system of roads and railways. The consequence is, that timber, even of moderate dimensions, commands high prices, and that the produce of thinnings finds a ready market. Under these favourable circumstances, most of these forests are worked on a short rotation, which, it will be evident from the preceding remarks, is always more likely to lead to good financial results, than if the woods were permitted to attain a great age. A large portion of this area has gradually been converted into pure spruce forests, managed on a rotation of eighty years. On other grounds, it may, perhaps, not have been wise to rely upon pure spruce forests. Up to the present time, however, there has been no serious damage from insects or fungi.

In most other countries of Germany the public forests—that is, those which belong to the State, to towns, village communities, and other public corporations, and most of the larger private forests—are managed on rotations considerably longer, and the consequence is, that the capital involved (soil and growing stock) does not yield as high interest as in the State forests of Saxony. The Spessart, for instance, an extensive forest area belonging to the State in the kingdom of Bavaria, contains a large growing stock of old oak timber, 250 to 450 years old, which, if cut and sold at the present time, would fetch about £1,500,000. The existing working plan governs operations during a period of 120 years, from 1888 to 2007, and particularly prescribes the manner in which the old standing oak timber shall be utilised. About 60 per cent. of the quantity alluded to consists of trees 300 to 450 years old, with hardly any volume- or value-increment. These it is proposed to cut during the next forty years. If they were cut now, and the proceeds were used to redeem part of the State debt, upwards of £27,000 a year would be saved in interest. The remaining 40 per cent. consists of trees now about 250 years old. These will furnish the yield in oak timber from 1936 to 1983, and when they are cut the volume will be greater, and the timber, being larger, will fetch much higher prices. Nevertheless, in the case of this portion, also, there will be considerable loss of interest. This sacrifice of interest is made deliberately by the Government of Bavaria, with the full consent of the Parliament at Munich, because it is considered desirable to maintain a regular supply of oak timber from this source, upon which numerous industrial establishments in the large villages all round the Spessart to a great extent depend.

And there are many other forest tracts in Germany of large extent, both public and private, which still contain enormous stores of old-growing timber, the inheritance of several centuries. In such cases it is right on many grounds to spread the removal of the old timber over a long series of years, and rather to work the forests on conservative than on purely financial principles. In Great Britain, however, circumstances are more similar to those which exist in Saxony, and hence, in the management of its woodlands, financial considerations will probably preponderate.

Part iii. deals with working plans; and this portion of the book cannot be sufficiently recommended to forest proprietors in Great Britain. In the first volume of his manual, Dr. Schlich justly drew attention to the large importation into the United Kingdom of timber and other forest produce, and he estimated that £12,000,000 a year represented the value of oak, birch, coniferous and other woods imported from abroad, that might be produced in Great Britain. This was in 1889; it was a cautious estimate, and since it was made, the imports into the United Kingdom have increased steadily.

Landed proprietors in Great Britain have fortunately not yet suffered to the same extent by the decline in the price of wheat and other agricultural produce, as proprietors in some parts of Germany. Yet their income has diminished, and in many cases it doubtless would be desirable to increase that income. Much might be done in this direction, if the management of existing woodlands were improved, and if land which it does not pay to keep under the plough, or to convert into grass land, were planted up and converted into forest. One objection commonly raised to this proposal is, that timber traders prefer imported to home-grown timber. That this is the case there is no doubt, and in the preface to the present volume Dr. Schlich explains the reason. Home-grown timber cannot, as a rule, compete with imported timber, because it has not grown up in dense compact masses. The woods are open, hence the bole is short, branched, and knotty. There are exceptions, but open park-like woods are the rule, and these cannot be expected to yield timber of good quality. A different system of sylviculture must be adopted. Of greater importance still is the adoption of regular systems of management. Timber of different kinds and of the exact qualities required by the market is imported regularly in sufficient quantities at the principal ports of the United Kingdom; the timber trader is able to make the needful arrangements to supply his customers, because he is certain that whatever he may require to meet their demands, will be available at the right time. Home-grown timber, on the other hand, is thrown upon the market in an irregular fashion. All at once heavy cuttings are made at one place, to provide money, or for other reasons, and then perhaps nothing is cut in the same district for years to come. The necessary consequence of such a system, or rather want of system, is that the timber is not sold at its full value. And when a calamity occurs, such as the storm of 1894, the timber blown down cannot be sold, except at ruinously low rates. The only remedy is the adoption of methodically arranged working plans in all forest tracts throughout the country. Among other things, such working plans determine the annual yield of each forest district. It does not follow that the yield once fixed must be pedantically maintained. A good working plan is elastic, and permits deviations to suit the interests of the proprietor. But if a methodical system of working is the rule in all forest districts, these deviations will generally compensate each

other, and the market will nevertheless be regularly supplied.

What, then, is a working plan? The German term is Wirthschafts plan, and the English term (working plan) was first used in 1856, when the writer of these lines commenced to work the Pegu teak forests on a regular system. The number of teak trees of the different age classes was approximately determined by an elaborate system of valuation surveys. It was found that the trees of the second class were sufficiently numerous to take the place of the first class trees, and that the same was the case with the younger classes. It was also ascertained, that twenty-four years on an average would be required for the trees of the second class to attain first class size. The result was that the removal of the first class trees, those which were fit to yield marketable timber, must be spread over at least twenty-four years; and upon this very simple principle, a working plan, intended to provide, in the first instance, for six years only, was established for the different forest districts. After the expiration of the first six years, this plan was renewed, and subsequently modified and elaborated in detail. The principle, however, has been maintained to the present day. These are the bare outlines of the scheme, which has not only ensured a sustained yield, but, and that is very important, has been readily intelligible to all.

(*To be continued.*)

THE NEW PROCESS FOR THE LIQUEFACTION OF AIR AND OTHER GASES.

THE liquefaction of air, and the rest of the so-called permanent gases, is an achievement which belongs to quite recent times. Faraday cooled and compressed gases by such means as were at his disposal, with results which are well known; but it was the experiments of Andrews, published in 1869, which taught physicists the fact that until the cooling has been effectual no amount of pressure will liquefy the gas; in fact, that every gas has a critical point below which its temperature must be reduced before pressure can bring about liquefaction. The critical points of oxygen and the components of air are very low. Hence it was not till 1877 that these gases were liquefied by Pictet and by Cailletet. The former reached the necessary temperature by two stages, using first liquid sulphur dioxide, then liquid carbon dioxide, both boiling under reduced pressure. Cailletet used the principle of cooling by sudden release from higher to lower pressure. The introduction of liquid ethylene as a cooling agent enabled experimenters to make another step forward; for, with the help of liquid ethylene, Wroblewski and Olszewski first obtained liquid oxygen in quantity far larger than would be possible in any form of Cailletet's apparatus, and without the complicated machinery of Pictet. Liquid oxygen itself thus became available as a refrigerating agent, and afforded the means of cooling a tube containing any other gas to a temperature lower than ever; namely, about 211° below zero Centigrade. With this cooling agent, and with the further cooling produced by expansion of the confined gas from a pressure of 150 atmospheres to 20 atmospheres, hydrogen has been liquefied by Olszewski. Suggestions have from time to time been made as to the possibility of applying the reduction of temperature, consequent upon the expansion of a gas when released from a high pressure, to the further cooling of the compressed gas; but no practical steps had been taken in this direction till the publication, in October last, of Herr Linde's successful liquefaction of air by the application of this principle. It now appears, however, that Linde has not only been anticipated in the application of the principle, but that a more effective apparatus than his has been devised. On Saturday, March 21, a demonstration was given, at Brin's Oxygen Works, of the construction and use of a new apparatus, the subject of an English patent, dated May 23, 1895, standing in the name of Dr. William Hampson. The apparatus consists of three coils of narrow copper tubing, arranged concentrically in a metal case, and connected successively together, as shown in the accompanying diagram (Fig. 1), which displays a vertical section of the apparatus. The gas, say oxygen, enters the outer coil under a pressure of 120 atmospheres, passing from this into the second, and from this into the central coil, which is surrounded by a

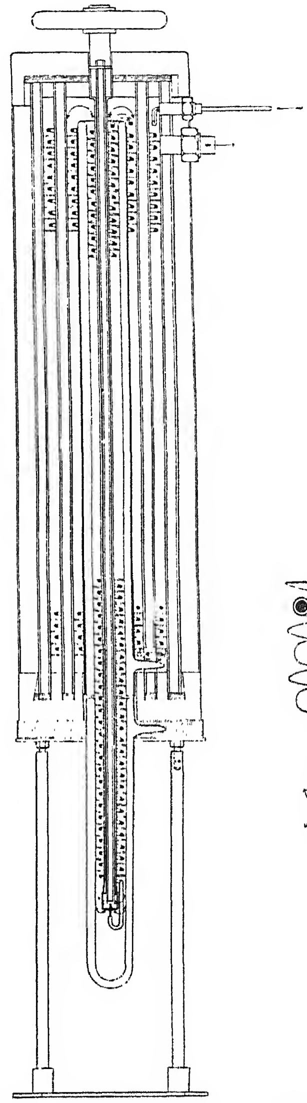


FIG. 1.—Sectional elevation.

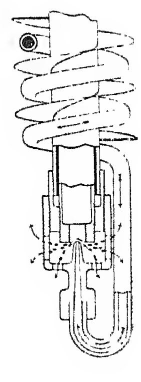


FIG. 2.—Detail of valve.

cylindrical glass vacuum-jacketed vessel as devised by Prof. Dewar. The two outer coils are separated from each other by vertical divisions of the case, and the spiral of the central coil is followed by a flat spiral of sheet copper. When the gas reaches the extremity of the central coil, it escapes through a fine orifice of peculiar construction, formed by bringing two knife-edges closely together (shown in Fig. 2). The size of the orifice can be regulated by means of an ebonite rod, which passes up the axis of the apparatus, and terminates in a handle at the top. After its escape the whole of the gas cooled by

expansion passes through the spaces surrounding the pipe through which the compressed gas is passing to the point of expansion, and so makes this gas, still under pressure, cooler than it was itself while under compression. The compressed gas consequently becomes at the point of expansion cooler than that which preceded it, and in its turn follows backwards the course of the still compressed gas, and so makes the latter cooler than before expansion, and therefore also cooler than ever after expansion. This intensification of cooling (always assuming sufficient protection against access of heat from the outside) is only limited by the liquefaction of the gas, the temperature of liquefaction being in the case of oxygen $-180°$ C. The apparatus exhibited measures 28 inches deep by 7 inches in diameter, and when once cooled down, that is, in about half an hour, it yields liquid oxygen at the rate of about seven cubic centimetres in four minutes. No carbonic acid, nitrous oxide, or other artificial cooling agent is employed either inside or outside the apparatus. With the liquid oxygen obtained, a series of interesting experiments were shown, which, however, were not in themselves new, such as the freezing of ether and alcohol, and the pulverisation of india-rubber after cooling. The expanded gas, after leaving the apparatus by the wide tube shown in the diagram, was led back to the suction pipe from which the pump was drawing. The impulse of the pump thus caused rhythmical variation in the pressure of the expanded gas over the surface of the liquid which had collected, and this in its turn produced a rhythmical variation in the small amount of ebullition visible in the liquid. Dr. Hampson's experiments, performed in the presence of a considerable number of representative men, constitute the first complete demonstration in England of the efficiency of the process of self-intensification of cold produced by expansion alone without the aid of extraneous artificial refrigeration.

It is obvious that the model exhibited admits of modification, both as to size and in some details of arrangement; but this ingenious adaptation of a well-known principle cannot fail to receive important practical applications. In the meantime the results already attained have the highest scientific interest. Among the more immediate consequences, we may look for the liquefaction of hydrogen in such quantities as to admit of the more exact study of the physical properties of this element in the liquid, and perhaps even in the solid state; while following upon this, the attainment of, or approximation to, the absolute zero of temperature cannot be far off.

ANIANUS JEDLIK.

On the 12th of last December, a month before having completed his ninety-sixth year, Anianus Jedlik, who had for half a century been an active labourer in the field of experimental physics, ended his lengthy career at the cloister of the Benedictine Order, in Györ.

It was a strange sort of an investigator's life that came to a close with Jedlik's death. We scarcely meet with his name in the international literature of natural sciences, and yet he worked a great deal and wrote a great deal; but he totally lacked the ambition to obtain the appreciation of foreign fellow-labourers in his branch of learning, for the results attained by him. To him, his researches in the world of physical phenomena afforded in themselves sufficient enjoyment; and his laboratory work thoroughly satisfied his unpretending nature, which was free from all desire for fame.

Stephen Jedlik, who as Benedictine monk adopted for his monastic name that of Anianus, was born on January 11, 1800, at Szimö, in the county of Komárom (Hungary). He frequented the Latin schools at Nagy Szombat and Pozsony. In 1817 he entered the bonds of the Benedictine Order at Pannonhalma, in 1822 he became Doctor of Philosophy, and in 1825 was consecrated officiating priest.

The talented young priest was intended by his Order for a professor, and so he was employed in teaching natural philosophy successively at Pannonhalma, Györ, and Pozsony. In 1840 he was appointed Professor of Natural Philosophy at the University of Pest.

Jedlik's scientific researches extended to various branches of natural philosophy; nevertheless he turned his attention principally to those physical phenomena which chiefly absorbed the learned men of the time at which he started upon his career, namely, those connected with galvanism and electro-magnetism.

Within the sphere of these, Jedlik succeeded in making two important discoveries, as we can prove with total certainty. But these discoveries now bear the names of others, who happened to make them independently of Jedlik, and hastened to make the scientific world acquainted with them, while he merely laid them before his own pupils.

It was in the first years of his professorship—in 1827–1828—that, upon reading about electro-magnetism in the German periodicals to which he had access, he modified Schweigger's multiplicator in the following manner. He put in the place of the magnetic needle an electro-magnet, and thus, with the aid of a current-commutator, produced permanent rotation.

Jedlik relates, in his modest manner, that he never came upon any mention of such electro-magnetic rotatory apparatus in any of the periodicals or works with which he was acquainted, so that he could not but believe that he was their discoverer. But he kept it to himself, as he had repeatedly experienced that descriptions of apparatus constructed by him after his own original ideas, already existed elsewhere; and so he never thought of sending descriptions of the above to any of the foreign scientific periodicals of which he knew.

Jedlik's other discovery had reference to the fundamental principle of the dynamo-electric machine. In the collection of the physical department of the University of Budapest, there is a machine of very primitive construction, dating, as it appears, from somewhere about the year 1860, and probably the work of some mechanician of Pest, to which are joined directions as to its use in Jedlik's own handwriting.

In the fourth point of these instructions we find clearly defined the fundamental principle of the dynamo-electric engine, which principle Werner Siemens brought before the Academy of Berlin in 1867, and according to which the magneto-electric currents of augmenting force may be developed by means of mechanical force, with the aid of the slight amount of magnetism contained in ordinary soft iron.

Jedlik discoursed with great zest upon his investigations at the meetings of natural philosophers and physicians, in whose publications his dissertations are to be found. Several of his treatises appeared in the publications of the Hungarian Academy of Sciences, which elected him its regular member in 1858.

The topics of some of his more important treatises are as follows: "The Deflection of Beams" (1845); "The Application of the Electro-Magnet in Electro-Dynamic Rotations" (1856); "A Modification of Grove and Bunsen's Battery" (1857); "The Magneto-Motor" (1857); "Concatenation of Leyden Jars" (1863), through which peculiar modification he attained a remarkable degree of effect; "Modification of Fresnel and Pouillet's Interference Apparatus" (1865); "Tubular Electric Collectors" (1867); "Electro-magnetic Undulation Machine" (1868).

With Jedlik there expired one of the typical figures of

the old school of physical experimenters who lacked that most important helper to their investigations—the knowledge of mathematics, but made up for this deficiency through a sort of intuitive perception when, led by a certain imaginative or creative faculty, they were able, with a sure hand, to grasp the very essence of a physical phenomenon.

With the present tendency of physical researches, this class of learned men could scarcely hold their ground; but, on the other hand, we must not disdain these mere experimenters, for they count among their number no less a man than the great Faraday.

Augustus Heller.

NOTES.

The adoption of the metric system by the United States seems to have received a notable impulse during the present week by the action of the Committee of Congress, which has reported in favour of its use by the United States Government in all its affairs except the completion of land surveys now in progress, on and after July 1, 1898, and its general use throughout the country on the first day of the twentieth century, January 1, 1901. The report is the outcome of a movement very early in this Session of Congress.

In accordance with a resolution of the House of Assembly of Cape Colony, carried last year, a Commission, consisting of the Hon. J. X. Merriman, Dr. Thomas Muir, Dr. David Gill, F.R.S., Mr. Thomas Stewart, and Mr. Charles Currey, has been appointed for the purpose of organising, controlling, and directing the work of geological exploration and survey in the colony. We are informed that the Commission has now appointed the under-mentioned gentlemen to begin the work of surveying and mapping the country:—Geologist, Dr. G. S. Corstorphine; Assistant Geologists, A. W. Rogers and E. H. L. Schwarz. As early as possible the Commission will publish and distribute a bibliography of South African geology.

It has been decided by the Huxley Memorial Committee to strike a medal for award by the Royal College of Science, London, and possibly for other purposes. The Committee desire to obtain the design for the medal, if possible, by competition. Further particulars will be furnished on application, which must be sent in before May 1 to the Honorary Secretary of the Huxley Memorial Committee, Prof. G. B. Howes, Royal College of Science, South Kensington, S.W.

We regret to see the announcement of the death of Mr. Charles Chambers, F.R.S., Director of the Colába Observatory. For the following particulars of his career, we are indebted to a long notice in the *Times* of India. Mr. Chambers was born at Leeds, Yorkshire, on May 30, 1834, and was consequently at the time of his demise in his sixty-second year. After finishing his education in his native place, he secured an appointment in the Kew Observatory, which he left in October 1863, to take up the post of assistant to the Director and Chief Superintendent and Electrician of the Indo-European Telegraph Department, Persian Gulf Section. In October 1865, he was temporarily appointed Superintendent of the Government Observatory, Bombay. After acting in that capacity for over two years he was confirmed in the appointment in January 1868, and continued to hold that office till November 1886, when he was given the appointment of Director of the Colába Observatory, which office he was holding at the time of his death. He was elected a Fellow of the Royal Society in 1869. He was also appointed a Fellow of the Bombay University in 1872, and a member of the Syndicate of the same University from 1879 to 1890. His contributions to scientific literature were very numerous, most of them being records and discussions of meteorological and magnetic observations in relation to solar changes.

Prof. N. A. Moos, of the Elphinstone College, Bombay, has been selected for the post of Director of the Government Observatory at Colaba, in succession to the late Mr. Charles Chambers.

The Annual Congress of the British Institute of Public Health will be held in Glasgow, from July 23 to July 28.

Dr. Samuel Wilks, F.R.S., was elected President of the Royal College of hysicians of London, at a meeting held on Monday.

Prof. Wyndham R. Dunstan, F.R.S., has been appointed Director of the Scientific Department of the Imperial Institute, which has hitherto been under the direction of Sir Frederick Abel. The principal work of this Department is to investigate new or little-known products from India and the Colonies, and to advise in reference to their commercial utilisation. Already much valuable work has been accomplished in this direction. With the aid of an increased grant from the Royal Commissioners of the 1851 Exhibition further additions to the staff of the Department will be made, and the Laboratory, which was fitted up in 1894 with the assistance of a grant from the Goldsmiths' Company, will now be considerably extended.

The College of New Jersey at Princeton is preparing to send an expedition to Patagonia for the purpose of securing fossils and large game. At a recent meeting of the Board of Trustees of the College, it was decided to change the charter name to Princeton University.

A few days ago M. Eugéne Fariot, an engineer of some repute and a worker in aeronautics, one of the siege aeronauts who escaped from Paris in the *Louis Blanc*, died at the age of sixty-eight. e has bequeathed a sum of £4000 to the Société française de Navigation Aerienne, of which he was a member. One half of this sum is to pay the expenses of experiments, and the other half to be funded in the name of the Society; the interest to be expended yearly on its behalf. Consequently, it is expected that an end will be put to the long stagnation in scientific aeronautics in France, owing to the indifference of the public authorities for an art so popular in that country.

For more than twenty years, the Sunday Society has been working "to obtain the opening of museums, art galleries, libraries, and gardens on Sundays." As already noted in these columns, the House of Commons on March 10 passed, without a division, a resolution in favour of this object. We are glad now to record that in the House of Commons on Monday, in answer to Mr. Massey-Mainwaring, Mr. Balfour said: "The Government are prepared to open South Kensington and Bethnal Green at a very early date—indeed, almost immediately. Those are museums under the control of the President of the Council. The National Gallery, the National Portrait Gallery, and the British Museum are in the hands of trustees, and correspondence is still going on between the Government and the trustees, though I have no reason to believe that any difficulty need be apprehended as to the final conclusion of a satisfactory arrangement." In fulfilment of this promise, it was announced yesterday that the South Kensington Museum, including the India Museum and Science Collections in the Galleries on the west of Exhibition Road, as well as the Bethna Green Branch Museum, will be open on Sunday next at 2 p.m. and will remain open till dusk.

An instructive case for the consideration of anti-vaccinationists is reported in Wednesday's *Times*. It appears that the guardians

of the Gloucester Union have for some years persistently neglected to perform their statutory duty under the Vaccination Acts, with the result that they now find themselves responsible for one of the most appalling outbreaks of smallpox which has for a long series of years visited any provincial town in England. During the last seven weeks, the notifications of fresh cases of smallpox in the cathedral city of Gloucester have enormously increased, the number of new cases during the past week being no less than 154, and the disease is still rapidly spreading. The guardians are now endeavouring to stem the disastrous torrent they have let into Gloucester by their non compliance with the laws of vaccination. About a week since they decided to attempt to undo the mischief of past years by passing a resolution deciding to enforce the compulsory clauses of the Vaccination Acts. It may be stated that the Town Council of Gloucester from the first have done their utmost by isolating the sick in hospital, by disinfecting houses, burning clothes and bedding, and placing relatives of sick in practical quarantine to stay the outbreak. Finding the outbreak gaining, they built extra hospitals, and have now hospitals for 120 patients, but the disease has continued to spread with such virulence that it is quite beyond their power to cope with it. A significant fact is that out of 90 deaths that have occurred in hospital up to March 27, 74 are among unvaccinated persons.

Individual enterprise is not often lacking in British commercial circles. Mr. R. K. Douglas gives an instance of this in the *Times*. He states that the Blackburn Chamber of Commerce have inaugurated a subscription, which now amounts to between £2000 and £3000, to provide sums for the purpose of sending out a commercial expedition to China, whose duty it will be to report on the state of trade in the interior of the country, the price of foreign goods in the native markets, the kinds of goods in demand, and the products and capabilities for trade of the inland districts. So far no assistance has been asked from the Government, and none has been given. But a point has now been reached when that modicum of official support which is necessary to the success of the expedition should be confidently asked for and promptly granted. Mr. Douglas is undoubtedly right in pointing out that if the expedition is not to prove a failure, the Foreign Office should supplement the efforts of the Blackburn Chamber of Commerce by giving it tangible support, and by appointing a member of the Consular Service in China to accompany the expedition on its travels. There should be no difficulty in doing this, and we hope with Mr. Douglas that the Government will give support to an undertaking which has for its important object the further promotion of British trade in the Far East.

Writing with reference to the aurora of March 4, it was suggested by Dr. M. F. O'Reilly, in our issue of March 12, that possibly Röntgen effects might be produced by auroral light. Mr. Donald S. Munro sends us a cutting from the Glasgow *Evening News*, in which he describes an experiment made to test this point. He says: "I put a rapid isochromatic plate in a camera slide, and covered the slide with black paper wrapped round several times, in case of any possible want of tightness in the slide. Several circular and triangular pieces of sheet-iron were placed beneath the paper, and next the lid of the dark slide. On developing, the result was no image. Perhaps, however, some one trying again with a brighter display and a longer exposure might get a result. I did not think of the experiment until the northern lights were beginning to fade, so my plate had only half an hour's exposure."

Statistics relating to the harvest gathered in from the sea around the coasts of the United Kingdom during 1895, are given in a return made to the Board of Trade, and published as a Parliamentary Paper. The statistics relate mainly to fish landed on the coasts of England and Wales, but summarised statements are also given of fish landed on the Scotch and Irish coasts. For purposes of comparison the statistics are given of the sea fisheries of Norway, Holland, France, and Canada. As regards England and Wales, the total value of the fish landed was £5,438,000. The corresponding values for 1893 and 1894 were £5,171,000 and £5,291,000 respectively. For Scotland the total value was £1,830,000, and for Ireland £269,000. In Scotland, during the year 1895, there has been a slight decrease in the quantity and an increase in the value of the fish landed as compared with 1894. In Ireland there was a decrease, both in quantity and value. The aggregate value for the United Kingdom during the year 1895 is £7,537,000, as compared with a total value of £7,260,000 in 1894. The figures for other countries during 1895 are not to hand, but for 1894 the values were:—Norway, £1,272,000; Holland, not accurately known, but probably less than Norway; France, £4,681,000; and Canadian Dominion, £4,317,000.

The report of the Departmental Committee appointed by the Board of Agriculture to inquire into the etiology, pathology, and morbid anatomy of swine fever has been issued as a Blue-book. The following conclusions are stated therein: (1) Bacteriological investigations prove that the cause of swine fever is a specific microbe. (2) Experience and observation prove that swine fever (both in its acute and chronic forms) is communicable from diseased to healthy swine by contact, and also by the agency of persons, animals, and substances which are capable of conveying the infective matter. (3) It has been shown that the pronounced symptoms which have hitherto been looked upon as essential to a correct diagnosis are not always present in the early stage of swine fever, and are almost constantly absent in the chronic form of disease. (4) The Committee regard it as an important outcome of the study of the morbid anatomy of the disease that some animals undoubtedly infected with swine fever presented only minute erosions in the intestinal canal, and that other animals, which had been suffering from either the acute or the chronic form of the malady, but which had recovered, showed only depressed scars which were apt to be overlooked at any but a very thorough *post-mortem* inspection. (5) From the experimental evidence it is concluded that a condition of plugging of the crypts on the ileo-cæcal valve cannot be accepted as an indication of swine fever.

The current number of *Weidemann's Annalen* contains an interesting paper by Herr Lang on the determination of the wave-length of Hertz electric waves. The method employed is similar to Quincke's method of measuring the wave-length of a musical note by arranging the lengths of two tubes which, starting from near the source of sound, are at their other ends brought together, so that the sound which has travelled along one tube interferes with that which has travelled along the other. Herr Lang uses an oscillator of Righi's form, consisting of two spheres. The tubes along which the electric waves have to pass are made of paper lined with tinfoil, and have a diameter of about 6 c.m. In order to detect the electric oscillations, a Branly tube (coherer) was employed. By placing a paraffin cylinder in one of the tubes the wave-length of the electric oscillation in paraffin, and hence the refractive index of paraffin, can also be measured.

The "Handbook of Jamaica" for 1896 is filled with historical, statistical, and general information concerning the island. This present issue contains in an appendix a useful article by Mr. W. Fawcett, Director of Public Gardens and Plantations in Jamaica on the planting and care of woodlands.

A SENSIBLE little pamphlet, entitled "Health Notes for the Seaside" (Whitby: Horne and Son), in which some of the salient facts of the science of hygiene are applied practically to every-day life and holiday seeking, has been written by Mr. A. C. Dutt. The "Notes" contain much good advice on how to make the best use of a brief holiday.

MESSRS. G. PHILIP AND SON have sent us a copy of the special map they have had prepared to illustrate the British and Italian operations in the Eastern Soudan and Red Sea littoral. The map shows the entire course of the Nile from the great lakes to the sea, and the approaches to Khartum from the east coast. Another map published by the same firm, shows on a large scale the present scene of operations in Egypt.

THE fifth part of the second volume of the *Proceedings* of the Imperial University College of Agriculture, Tōkyō, is occupied by two papers, both in German, on Japanese trees in the winter state, illustrated by thirteen plates, and on the shrinking (*Klemmen*) of the Japanese timbers which are most useful for practical purposes.

THE "Hand-list of Coniferæ grown in the Royal Gardens, Kew," just issued, comprises 227 species, with 340 varieties. It has been drawn up with the assistance of Dr. M. T. Masters, and is preceded by a very valuable historical sketch of the nomenclature and classification of the *Abietineæ*, from the pen of Sir Joseph D. Hooker.

A KIND of German *Kew Bulletin* is announced, with the title *Notizblatt des königlichen botanischen Gartens und Museums zu Berlin*, under the direction of the staff of the Royal Garden and Museum at Berlin. It is to be devoted to the botanical interests of the German colonies, to the presentation of results which it is desirable to place promptly before those interested, and to the publication of new species.

WITH the view of bringing together the opinions of persons interested in reptiles, and with the laudable intention of educating people to a kinder feeling for these interesting creatures, *The Vivarium* has been started. The first number has been produced by a lithographic process, but the promoters hope to elevate the contributions to the dignity of print in the near future. The periodical is intended to be the organ of the newly-formed Reptilian Society, and copies can be obtained from the Secretary, Rand Rectory, Wragby, Lincolnshire.

A SIXTH revised edition of Prof. C. Gegenbaur's "Lehrbuch der Anatomie des Menschen" has been published by Engelmann, of Leipzig, in two ponderous volumes. The work was originally published in 1883, and took its place in the first rank among reference books of anatomy. The revisions ensure that the new edition will maintain the high position earned by the original. Another new edition, received during the past few days, is the seconds of "Geology and Scenery of Sutherland" (Edinburgh: D. Douglas), by Mr. H. M. Cadell. The book is a worthy example of a guide-book which has nature for its subject, and is a desirable companion for visitors to the rocky wilds of Sutherland. Would there were similar volumes for every county in the British Isles. Many instructive diagrams and full-page illustrations are distributed through the pages of the book.

THE Royal Agricultural and Commercial Society of British Guiana may not be progressing so much as it deserves, if progress is counted by an increased roll; but its admirable journal, *Timehri*, the December number of which (vol. ix. part 2) has come to hand, testifies to the existence of a healthy spirit of inquiry, which assists in the progress and development of the great colony with the affairs of which it is chiefly concerned. Among the subjects of papers in the present number are: "Food Adulteration," by Mr. L. M. Hill; "The Relation of Boiling Temperatures in Multiple Evaporation," by Mr. F. I. Scard; "Ethnological Notes from Pirari," by Mr. C. A. Lloyd; "The Materials of the Urali Poison," by Mr. J. J. Quelch; "Some Guiana Parrots," by Mr. C. A. Lloyd; and two articles by the editor, Mr. James Rodway—one on the future of the Negro, and the other on the old boundary of Essequibo. In view of the fact that Venezuela lays claim to the whole of Guiana west of the Essequibo, it is well to call attention to this article, in which Mr. Rodway shows the baselessness of such a claim. The London agent of *Timehri* is Mr. E. Stanford.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. S. C. Fisher; a Silver-backed Fox (*Canis chama*) from South Africa, presented by Mr. C. W. Southey; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Miss E. S. Young; two Crowned Dricker-Boks (*Cophalophus coronatus*, ♂ ♀) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE STARS.—The *Harvard College Observatory Circular*, No. 6, announces that an examination of the Henry Draper Memorial photographs of stellar spectra by Mrs. Fleming has led to the discovery of fourteen new variable stars of long period, in addition to those previously announced. The spectrum of the fifth star in the following list is of the fourth type. All of the others have spectra of the third type, having also the hydrogen lines bright, and it was this peculiarity which led to their discovery. The variability has been shown by comparison of a large number of photographs, and the variation has been confirmed in each case by Prof. Pickering.

Constellation.	Designation.	R. A. 1900.	Dec. 1900.	Magnitude.		Date of next Maximum.
				Br.	Ft.	
		h. m.	° ′			1896
Sculptor	−39° 16	0 3·6	−39 47	8·9	<12·1	May 25
Columba ...	A.G.C. 6135	5 15·6	−33 48	7·6	11·3	June 23
Canis Minor...	...	7 1·5	+ 9 1	10·3	<13·7	Sept. 11
Virgo	+ 5° 2708	12 57·6	+ 5 43	8·8	9·7	...
Apus	...	14 59·3	−71 40	9·0	<11·4	...
Sagittarius ...	−33° 13234	18 21·4	−33 23	8·2	12·3	July 2
Sagittarius ...	−19° 5347	19 8·1	−19 2	9·7	11·1	...
Sagittarius ...	...	19 8·7	−18 59	9·9	<13·3	...
Pavo	...	19 39·5	−72 1	7·6	12·1	Aug. 29
Microscopium	A.G.C. 28038	20 21·8	−28 35	7·4	8·4	...
Pavo	...	20 47·2	−63 5	9·6	<12·3	...
Grus	−38° 15044	22 19·9	−38 4	8·6	11·0	...
Grus	...	22 19·9	−48 57	7·2	12·3	May 10
Aquarius ...	−16° 6379	23 47·1	−16 25	8·2	9·3	...

COMET PERRINE-LAMP.—The following is a continuation of Dr. Lamp's ephemeris of Comet Perrine-Lamp for Berlin midnight (*Ast. Nach.*, 3341):—

		R.A.		Decl.		Brightness.
		h. m. s.		° ′		
April 3	...	4 19 25	...	+42 4·7	...	0·023
6	...	24 49	...	41 36		
9	...	29 45	...	41 10·6		
12	...	34 21	...	40 48·3		
15	...	38 39	...	40 28·4	..	0·012
18	...	42 45	...	40 10·8		
21	...	46 39	...	39 55·3		
24	...	50 23	...	39 41·4		
27	...	53 59	...	39 29·0	...	0·007
30	...	4 57 28	...	+39 18·0		

Mr. Joseph Lunt reports that on March 1, 2 and 3, the comet appeared as a circular nebulosity without tail, but with a bright central condensation, which very gradually faded away outwards. It was as bright as the nucleus of the great nebula in Andromeda, which it somewhat resembled, and was easily seen with a telescope of one-inch aperture. On March 9 the aspect of the comet was greatly changed, a bright stellar nucleus having developed; this was not centrally placed, and gave the comet a fan-shaped appearance.

During April the comet passes from near 58 Persei to a little south of η Aurigæ. In the latitude of London it is circumpolar throughout the month.

SEARCH EPHEMERIS FOR COMET 1889 V.—The following search ephemeris for the expected return of Comet 1889 V (Brooks) is given by Dr. Bauschinger (*Ast. Nach.*, 3334):—

	R.A. h. m. s.	Decl. ° ′	Brightness.
April 2	20 40 24	−24 9	0·17
6	47 3	23 50	0·18
10	53 35	23 31	0·19
14	21 0 3	23 12	0·20
18	6 24	22 52	0·22
22	12 39	22 32	0·23
26	18 47	22 12	0·25
30	24 47	21 53	0·27
May 4	30 40	21 33	0·28
8	21 36 25	−21 14	0·29

The ephemeris is for Berlin midnight, and the unit of theoretical brightness is that on 1889 July 8, the date of the first accurate observation. When last seen in January 1891 by Prof. Barnard at the Lick Observatory, the calculated brightness was 0·08, so that the comet should even now be brighter than when it was last observed; it is, however, not very favourably situated for European observers. During April the motion of the comet is a little north of the line from ψ to ζ Capricornii.

INSTITUTION OF NAVAL ARCHITECTS.

THE annual spring meeting of the Institution of Naval Architects was held last week, commencing Wednesday, the 25th ult., and being carried over Thursday and Friday, the two following days. The new President, the Earl of Hopetoun, who has succeeded Lord Brassey, occupied the chair throughout the meeting.

There was a long list of papers to be read, the following being on the agenda:—

(1) "Watertight Doors, and their Danger to modern fighting Ships," by Captain the Right Hon. Lord Charles Beresford, C.B., R.N.

(2) "Watertight Doors," by Colonel Nabor Soliani, Director of Naval Construction, Royal Italian Navy.

(3) "Some Geometry in Connection with the Stability of Ships," by J. G. Bruhn.

(4) "The Causes of Mysterious Fractures in the Steel used by Marine Engineers as revealed by the Microscope," by A. E. Seaton.

(5) "The Measurement of Feed and Circulating Water, &c., by Chemical Means," by C. E. Stromeyer.

(6) "Salvage Appliances," by J. G. Kinghorn.

(7) "Compound Marine Boilers," by Colonel Nabor Soliani, Director of Naval Construction, Royal Italian Navy.

(8) "Water-tube Boilers," by J. Watt.

(9) "Circulation in Water-tube Boilers," by Prof. W. H. Watkinson.

(10) "The Non-uniform Rolling of Ships," by R. E. Froude, F.R.S.

(11) "A New Theory of the Pitching Motion of Ships on Waves, and of the Stresses produced by this Motion," by Captain A. Kriloff, Professor at the Naval Academy of St. Petersburg.

(12) "Notes on the Carriage of Grain Cargoes," by George Herbert Little.

The paper by Lord Charles Beresford set forth the views of a naval officer on the question of watertight doors. It may be said generally that the piercing of bulkheads has been done at the request, or perhaps more correctly speaking, the insistence of naval officers, who have found it difficult to work their ships with partitions in them not allowing means of ingress and egress from one compartment to the other. Lord Charles Beresford, however, differs from the majority of naval captains, and considers that bulkheads are too much pierced. He would do away with a large number of openings in a ship. He tells us that in the *Magnificent* and *Majestic*, which are the most powerful battleships in the service, and, therefore, in the world, there are 150 compartments in each ship, and 208 doors. Many of these of course are not in positions which are of vital importance, so far as flooding of the ship would be concerned in case of accident. He proposes to do away with nineteen of these doors in the most important part of the ship, and twenty-three would be made smaller, or modified so as to give additional safety in accordance with his proposals. This would undoubtedly add to the safety of the ship, and equally without doubt it would detract from the convenience of those inhabiting it. The latter may seem at first a small matter, but, as was pointed out during the discussion which followed the reading of the paper, convenience is to a large extent a measure of efficiency in action. In fighting a ship it is necessary for the men to move from part to part with great rapidity. This naturally means openings in bulkheads; for if a man, say the chief engineer, in order to get from one part of the vessel to another, has to climb up on deck to surmount a bulkhead, and descend on the other side, time will be occupied in the transition. In the rapid handling of ammunition, also, it is absolutely necessary that direct access should be obtained to various compartments; whilst for bringing coal from the bunkers to the stokehole floors, divisions must have openings made in them. It is also necessary to consider the question of habitability. A ship requires ventilation, otherwise it is impossible to live in her; at present a good deal of space is given to steam fans and air conduits, for this purpose. If bulkheads are to be unpierced, the difficulty of ventilation becomes more pronounced. It will be seen, therefore, that the question of openings in bulkheads, whether fitted with water-tight doors or not, is not of so simple a character as might at first appear. In fact in this element of warship design, as in all others, "compromise" must be the watchword. It is necessary not only for naval officers but for naval architects as well to meet and discuss this matter. Up to the present it has been rather that the naval officer has demanded watertight doors, and the ship designer, or naval architect, has opposed the demand. It is evident, from the discussion which followed the reading of Lord Charles Beresford's and Colonel Soliani's papers, that opinions are divided. It is essential that the matter should be threshed out, and the best compromise, according to our lights, should be adopted.

Colonel Soliani's paper dealt with different forms of watertight door. It was very fully illustrated, and will be a valuable source of reference to shipbuilders and naval architects.

In Mr. Bruhn's paper the question of stability of ships was treated, both in an historical and a mathematical manner. This contribution was read in brief abstract, and there was practically no discussion upon it. It is not one that would bear condensation very readily, and in any case could not be understood without the use of the diagrams which accompanied it. It dealt with the problem of constructing geometrically a set of cross curves of stability for inclinations from 90° to 180°, the corresponding curves from zero to 90° being known. Another section dealt with the determination of the direction in which the centre of buoyancy moves when a ship is inclined in a given direction. Lines of curvature and geodetic lines as curves of buoyancy, relations between the surfaces of buoyancy and flotation, and an extension of Leclert's theorem were subjects also dealt with; whilst the paper concluded with a geometrical construction for finding the length n, or the radius of curvature of the curve of flotation, from the usual information given on metacentric diagrams.

Mr. Seaton's paper was an extremely interesting one, and will prove of great practical value to engineers. As is well-known, the author is the managing director of Earle's Shipbuilding and Engineering Works at Hull. Some time ago part of the shafting of a screw steamer with which he had to do suddenly gave way. This shaft was made of steel containing from 0·2 per cent. to 0·25 per cent. of carbon, and its ultimate tensile strength was guaranteed to be not more than 30 tons, with an elongation of 25 per cent. in 5 inches. Mr. Seaton determined to make an inquiry into the composition of this shaft, and for that purpose it was subjected to chemical analysis. We need not repeat this analysis; it will be sufficient to state that it showed a very high proportion of undesirable elements in the steel. The most interesting part of the investigation was that carried out by Prof. J. O. Arnold, of Sheffield, who prepared micro-sections in the usual way. The chief point of the paper consists in the fact that chemical analysis is shown to be insufficient to give the engineer information as to the value of a given steel used for structural purposes. For instance, sulphur which is objectionable under certain conditions may be present to a considerable extent in a steel casting or forging, but though it may be of no serious moment if in one form, will be conducive to most disastrous results in another form. The chemist, as Mr. Seaton pointed out,

is only able to state the quantity of sulphur present; but whether in a dangerous or non-dangerous form, he is unable to say. Mr. Seaton concludes, therefore, that chemical analysis alone is sufficient neither for steel nor for any other combined metal used by the engineer; while, on the other hand, the microscope reveals the actual structure of the material, and shows most distinctly whether it is a safe or an unsafe one. It appears, therefore, that the use of the microscope is likely to be of the utmost advantage to the marine engineer. We have not space to give the details by which Mr. Seaton supports his contention. The subject, however, is one well worthy of attention on the part of engineers, and scientific experts who work for them.

Mr. Stromeyer's paper was also one of interest. He proposes to measure the quantity of water either fed into a boiler, or passing through the condenser, by chemical means. A measured quantity of salt water is slowly injected, say into the condenser of an engine while at work; subsequently a chemical analysis for salt is carried out, both on a sample of sea-water and on a sample of the water to be measured. Their relative salinities would then give the quantity of water pumped, or the amount of steam condensed for any given period. The method is one which will probably be useful for estimating the quantity of circulating water used by the marine engineer, as it is capable of being applied to large quantities of flowing water with comparative facility. For the smaller volumes of water used for feed, which can be passed through pipes of moderate dimensions, the water-metre would, we think, be preferred by the majority of engineers; although, perhaps, the measuring-tank would command the greater confidence than either.

Mr. Kinghorn's paper, on salvage appliances, was of considerable practical interest. It referred to a new system of wreck-raising which has been evolved by certain salvage agents and marine engineers of Liverpool. This country is lamentably deficient in wreck-raising facilities, a fact which has been proved by the resource that has been had to foreign "wrecking" companies, when vessels of exceptionally large size have had to be raised. The case of the battleship *Howe*, at Ferrol, which was lifted by a Scandinavian company, and of the Atlantic liner *Eider*, wrecked on our own coast, and lifted by the same company, are instances in point.

The only evening sitting of the meeting, which was held on Thursday, the 26th ult., was devoted to the great water-tube boiler question, which is now agitating the marine engineering world. Of the three papers set down for reading, that of Prof. Watkinson was by far the most important. Colonel Soliani proposed a combination of fire-tube and water-tube boiler, which did not meet with universal approval during the discussion. Mr. Watt described certain experiments that he had made many years ago, and which could hardly be described as crucial. Prof. Watkinson attacked the great problem of circulation, the vital question certainly in water-tube boilers, and also to a far greater extent than has been supposed, in boilers of the shell, or fire-tube class. The circulation of water and steam in a water-tube boiler involves some very nice questions in physics. Its study affords a good opportunity for those highly skilled in physical science to assist the engineer in arriving at definite conclusions as to what causes govern the flow of water and steam in pipes subjected to heat. There were three types of boiler chiefly dealt with by Prof. Watkinson. The Belleville boiler, a French invention, which has now been in use for a number of years. It consists of a series of pipes of comparatively large diameter, say four inches to five inches; these are arranged in a continuous zigzag form, and subjected to the heat of the furnace; the water flows upward through this serpentine course, steam being generated in its course, and that water which is not converted into steam flows down external pipes, and then again passes into the bottom of the steam-generating pipes. In this way a continuous circulation is kept up. The distance the water has to travel through, from one end of the serpentine to the other, is considerable. The various lengths of pipe are not much inclined from the horizontal, and the sudden bends at the ends of each pipe tend to check the flow. It is believed that for this reason the Belleville boiler will not stand forcing—that is to say, only moderate quantities of coal can be burned to each unit of grate surface. For if rapid evaporation be attempted, the tubes are apt to be denuded of water. Judging by the recent trials of H.M.S. *Sharpshooter*, there would appear to be some truth in this contention. How far it applies, however, is a matter which experiment alone can reveal, and the results of such experiments, even if made, are not yet available so far as we are aware.

The other two kinds of boiler dealt with were of what is known as the "express" type—that is to say, they are boilers which will bear forcing, so that large quantities of fuel can be burned in a given time, and the rate of evaporation thus made very high. These are the well-known Thornycroft and Yarrow types of boiler, which have been so successfully applied to the torpedo-boat destroyers, which have given such remarkable results of late, in the matter of quick steaming. Although both the Yarrow and Thornycroft boiler have small tubes, say about one inch in diameter, which are comparatively short in length, each tube connecting directly with the top and bottom vessel, yet the two types have fundamental points of difference. The Thornycroft boiler has outside down-comers and bent tubes which discharge into the top drum above water. The Yarrow boiler has straight "drowned" tubes. These expressions require some further explanation. Each boiler consists essentially of a top drum or steam vessel, and two bottom drums or wing cylinders. Looked at in sectional elevation, these three drums form the points of a triangle standing on its base. The sides of the triangle are composed of the steam-generating tubes; the base is composed of the fire-grate. The products of combustion ascend from the grate amongst the tubes, and pass off to the furnace. In the Thornycroft boiler the outline formed by the three cylindrical vessels, and the connecting steam-generating tubes, is not strictly triangular, as the tubes are bent, as already stated. This bending enables them to be inserted into the top drum above the water-level carried into the latter. In the Yarrow boiler, the straight tubes pass in a direct line from the bottom vessels to the top drum, and therefore enter the bottom part of the latter, and, consequently, are below the water-level.

We will first trace the course of circulation of water in the Yarrow boiler. As there are several rows of tubes on each side of the furnace, those on the inside are naturally subjected to the greater heat. In them, as steam is first generated, the bubbles of steam rise, and water flows with them. To make up the deficiency thus caused in the content of the tube, water flows down the back tubes furthest from the fire, into the bottom vessel, which is common to all tubes on that side of the furnace, and then ascends those tubes where steam has been generated. In this way a continuous circulation is kept up. In the Thornycroft boiler this cycle cannot exist, as the tubes deliver above water, therefore special down-comer tubes have to be fitted; these enter the top drum below the water-level. Circulation takes place as follows. When the hot gases ascend among the bent steam-generating tubes, steam is generated. The tubes being small, it forces upward a certain quantity of water, which then falls into the top drum, and flowing down the downcomers, is able to rise again in the generating tubes to make up the deficiency. Circulation is, of course, due to the difference in specific gravity of the upward and downward columns of water in the generating tubes, and the down-comers, respectively. For some time past controversy has ranged between two schools—one favouring drowned tubes and anti-down-comers, the other undrowned tubes and down-comers, each maintaining that boilers constructed according to their views have most efficient circulation. Prof. Watkinson's paper dealt with this question, but no final opinion was expressed as to the respective values of the two types of boiler. The Professor had brought from Glasgow the glass model boilers with which he had made a number of experiments. Unfortunately, when he attempted to repeat these at the meeting, the breakage of tubes prevented him from carrying out his full programme. This is much to be regretted, as the experiments are of a very interesting nature. It is to be hoped that at no distant date Prof. Watkinson will have an opportunity of repeating them.

The last day of the meeting was devoted to two papers on pitching and rolling of ships. Mr. Froude's paper was practically a reply to one recently contributed by M. Émile Bertin, the eminent French naval architect, at the last meeting of the Institution; which in turn was a continuation of a paper by the said author read at a previous meeting. Without referring at length to these two papers it would be useless to attempt to give the substance of Mr. Froude's contribution, even if we had space to do so. It may be said, however, that Mr. Froude does not agree generally with M. Bertin. What the points of disagreement are, it would be impossible to explain without the aid of many diagrams, upon which the author relied for making his explanation clear. We must therefore refer our readers to the

Transactions of the Institution for information upon this intricate but extremely interesting subject.

Captain Kriloff's paper was of a completely mathematical character, and indeed was of far too abstruse a nature to follow during the reading. It depended on an appendix of many pages containing columns of figures which would require carefu study to master.

Mr. Little's paper was of practical interest to those concerned in the carriage of grain.

The proceedings were brought to a close by the usual votes of thanks.

The summer meeting this year is to be held in Hamburg during the early part of June. Extensive preparations have been made for the reception of members, and there is no doubt the meeting will be of quite an international character. The success of last year's meeting in Paris has encouraged the Council to go abroad again.

It may be added that the Institution is increasing in numbers at a rapid rate, there being a greater addition to the roll of membership at this meeting than has ever before taken place.

RECENT WORK WITH RÖNTGEN RAYS.

SEVERAL important communications referring to work upon Röntgen rays have come before our notice during the past week. While some experimenters are perfecting the methods so as to develop the capabilities of the rays, others are investigating the physical characteristics pertaining to them, and in both directions of work clear advances have been made since our last eclectic statement of the contributions to the subject founded by Röntgen's discovery.

Prof. Alfred M. Mayer, of the Stevens Institute of Technology, has sent us the following account of experiments carried out by him on the polarisation of Röntgen rays.

"Of the remarkable properties of the Röntgen rays, the one of the greatest interest is that these rays are not polarisable; for this property shows that these rays, unlike those of light, are not propagated by vibrations transverse to the direction of their progress. To decide conclusively this point certain properties, shown by Röntgen's experiments, must be possessed by the substance which is to act on the Röntgen rays, viz. (1) a low density; (2) the substance must be very thin, and yet give complete polarisation to transmitted light. These two properties are eminently peculiar to herapathite, an iodo-sulphate of quinine. Its density is only 1·8, and crystals of herapathite of only 0·05 mm. in thickness, with their axes crossed at 90°, entirely obstruct the incident light, so that their crossed portions appear intensely black.

"Six discs of glass, 0·15 mm. thick and 25 mm. in diameter, were covered with crystal-plates of herapathite crossing one another at various angles. Where they crossed at right angles they gave a black field. These discs were fastened to the surface of a screen of compressed brown paper, which was found to be impervious to the actinic action of a powerful arc light acting during two hours, and placed 1 foot in front of the screen; the latter covering a sensitive photographic plate. On this screen were also placed three discs of the same glass, overlapping one another, so that 1, 2, and 3 thicknesses of the glass had to be traversed by the X-rays before they reached the photographic plate. These discs served as standards with which to compare the action of the X-rays on the discs covered with herapathite. On the same screen was also placed a square of yellow blotting-paper, $\frac{3}{4}$ mm. in thickness, having on its surface superposed herapathite crystals from two to four layers deep.

"This screen so prepared, and covering a sensitive plate, was exposed to the radiations of the Crookes' tube; in the first experiment for half an hour, in the second for one hour, and in the third for two and a half hours. On developing these plates there was not the slightest trace of the presence of the herapathites. The photographs of the glass discs had not the slightest mottling on their surfaces. Their surfaces appeared throughout to the unaided eye, and also when examined with a magnifying glass, with a uniform illumination and grain throughout. The herapathite, of the thickness used in these experiments, does not appear to screen at all the X-rays; for all the discs carrying it appeared exactly alike, in illumination and in grain, to the photograph of a similar disc having nothing on its surface. But the action of the rays on the square of blotting-paper carrying the herapathites showed this in a more conclusive manner; for where this paper covered the photographic plate nothing was visible, except by the most careful scrutiny, and with the most favourable illumination, and then a mere ghost of the paper could be detected, but with no traces whatever of the herapathites.

"These experiments appear to have shown conclusively what Röntgen found by his experiments; viz. that the X-rays are not polarised by passing through doubly-refracting media."

At a recent meeting (March 3) of the Dublin University Experimental Science Association, Dr. J. Joly, F.R.S., described experiments made by him on the "Lenard-Röntgen" rays. He has found that the rays are reflected at the surface of mercury, lead, glass and wood. A photographic plate was enclosed in a light-tight carrier of millboard, upon the outside of which a copper ring was attached. This was exposed in the geometrical shadow of a thick lead plate to rays which entering a slot in the plate were reflected at the surface of mercury. An exposure of over an hour gave the shadowgraph of the ring. The position of this upon the plate indicated that the rays had approached from the direction of the reflecting mercury surface. Removing the dish of mercury, a much fainter image was obtained apparently from rays reflected from the wood beneath.

If the rays are received upon the carrier after passage between two parallel lead plates, the dark band formed upon the sensitive plate will be found to be bordered by heavy black lines. This was traced to a very complete reflection at grazing incidence to the lead plates, corresponding to the manner in which light is reflected at grazing incidence. A photographic plate exposed to light passing between the lead plates shows, in fact, a similar dark border; substituting glass plates for the lead, similar effects were obtained. This marked grazing reflection rendered it possible to concentrate the rays to an imperfect focus by causing them to pass through a conical tube of lead open at both ends, when a strengthening of the effects was formed on exposing at the narrow end of the cone.

Before the Royal Society on March 19, Lord Blythswood described some experiments which indicate that the X-rays can be reflected. He placed a vacuum-tube, A (Figs. 1–2), behind a lead screen, B B, 18 in. × 12 and $\frac{1}{8}$ thick. The screen had a 2-in. hole in it with a 2-in. pipe attached; 4 in. from the vacuum-tube was placed a speculum-metal mirror D, 4 in. × $2\frac{1}{2}$, at an angle of 45° with the lead screen; 4 in. from the mirror was a light-tight zinc box, E, with aluminium window, F; inside came first the objects, G, stuck on to a black cardboard, H, then I, the photographic plate. The following objects were photographed in about twenty minutes: (1) Some brass clock wheels. (2) A screw-cutting gauge. (3) Two lead discs. (4) The mirrors, being two pieces of speculum-metal used by Lord Blythswood to divide upon.

Two other papers were read before the Royal Society at the same meeting. In one of these, Mr. R. Erskine Murray described experiments made in the Cavendish Laboratory of the University of Cambridge, at Prof. J. J. Thomson's suggestion, in order to find whether the contact potential of a pair of plates of different metals is in any way affected by the passage of the Röntgen X-rays between the plates.

The vacuum bulb and induction coil for the production of the rays were enclosed in a box lined with metal, so that the plates and the apparatus used in measuring their contact potential difference should be screened from any direct electrical disturbances. At one side of the box there was a circular hole of about 3 cm. in diameter. The vacuum bulb was placed just inside this hole, and directed so that the rays should stream out through it in a direction perpendicular to the side of the box. In some experiments this hole was closed by a tinfoil screen, which allowed a large proportion of the rays to pass out while shutting in ordinary electrical disturbances. The plates whose contact potential difference was to be measured were placed at a short distance outside the box, in such a position that the rays could fall on them.

To measure their contact potential, Mr. Murray used the null method described by Lord Kelvin in his paper given to the British Association in 1880. In this method the value of the contact potential is found by measuring the amount of the counter potential which has to be applied to the pair of plates to reduce the potential difference between their opposing surfaces to zero. The counter potential introduced to effect this annulment must obviously be equal and opposite to their contact potential difference. Hence the numerical value of the latter is simply

that of the applied counter potential, but is of opposite sign. The plates were of zinc and tinfoil, the latter being mounted on thin ebonite to keep it flat. They were placed parallel to one another at a small distance apart, so that the rays fell perpendicularly on the back of the tinfoil plate, passed through it and the air space between them, and were absorbed by the zinc. The tinfoil plate was insulated and connected to the insulated quadrants of a Kelvin quadrant electrometer. The zinc was uninsulated, and was connected to the uninsulated quadrants of the electrometer. This plate was movable in a direction perpendicular to its plane, and could thus be drawn away from the tinfoil. If there was any electric potential difference between the opposing surfaces of the two plates, further separation caused a change in it which, reacting on the electrometer, deflected it.

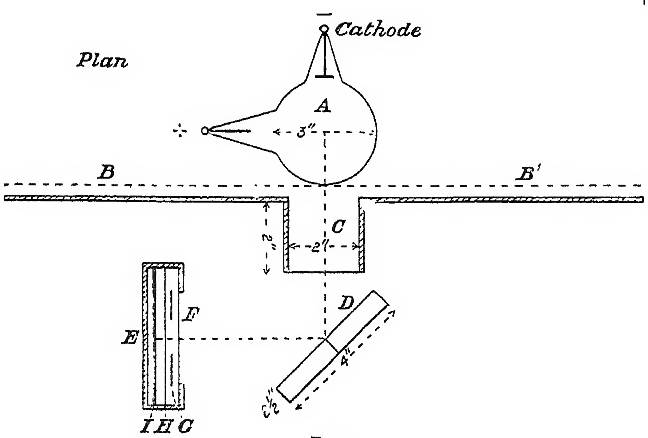


FIG. 1.

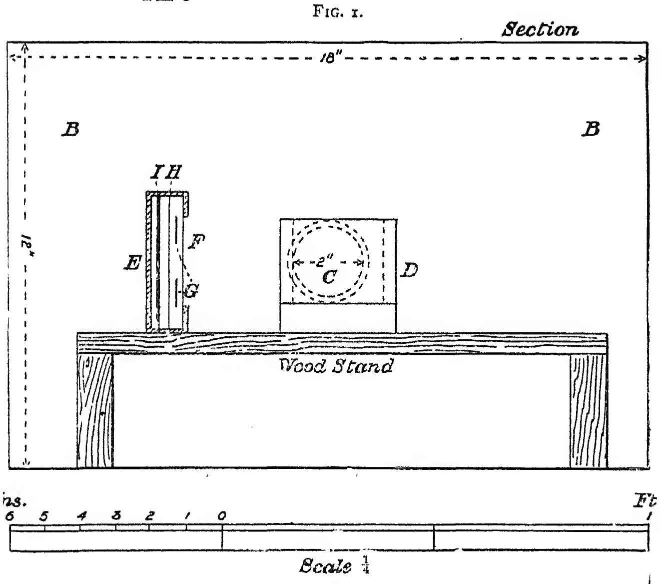


FIG. 2.—A, vacuum tube; BB', lead plate, 18 in. × 12 in. ⅛ in. thick; C, hole 2 in. diameter. Pipes 2 in. diameter × ½ in.; D, speculum-metal mirrors; E, zinc box, 4 in. × 4 in., 1 in. deep; F, aluminium window; G, objects; H, black cardboard; I, photographic plate.

Experiments conducted with this arrangement led Mr. Murray to conclude that (1) the influence of the rays on the zinc and tinfoil plates does not cause any direct or sudden change in their contact potential, but that (2) the air through which the rays pass is temporarily converted into an electrolyte, and when in this condition forms a connection between the plates which has the same properties as a drop of acidulated water, namely, it rapidly reduces the potential between the opposing surfaces of the plates to zero, and may even reverse it to a small extent.

It is pointed out that this electrolytic property was found by Lord Kelvin ("Electrostatics and Magnetism," Art. xxiii, §§ 412—414) to be possessed by the fumes from a burning spirit lamp. In both cases its cause is probably the same. It is, no doubt, due to a want of electrical equilibrium among, and a partial dissociation of, the molecules of the gas.

In the third of the Royal Society papers referred to in the foregoing, Mr. C. T. R. Wilson gave an account of experiments made to determine the effect of Röntgen rays on cloudy condensation. The author has previously shown that cloudy condensation takes place in the absence of dust when saturated air suffers sudden expansion exceeding a certain critical amount. He now finds that air exposed to the action of Röntgen rays requires to be expanded just as much as ordinary air in order that condensation may take place, but these rays have the effect of greatly increasing the number of drops formed when the expansion is beyond that necessary to produce condensation. It is concluded that when the Röntgen rays pass through moist air they produce a supply of nuclei of the same kind as those which are always present in small numbers, or at any rate of exactly equal efficiency in promoting condensation.

At the Royal Dublin Society, on March 18, Mr. Richard J. Moss read a paper on the Röntgen X-rays. The mixed gases obtained by the electrolysis of hydrochloric acid were submitted to the action of X-rays. The apparatus employed was similar to that devised by Bunsen and Roscoe for their "Photo-Chemical Researches" (*Phil. Trans.*, vol. cccxlvii. p. 355). Every precaution was taken to ensure that the hydrogen and chlorine were in atomic proportions, and free from impurity. It was found that the X-rays, at a distance of 5 centimetres from the Crookes' tube, caused no combination of the hydrogen and chlorine. The combination of 0·1 per cent. of the volume of gas operated upon could not have escaped detection. The X-rays from the Crookes' tube employed were sufficient to produce fluorescence in a crystal of lithium rubidium platinocyanide at a distance of 2 metres. The examination of a series of crystalline platinocyanides showed that lithium rubidium platinocyanide emitted the brightest light under the influence of the X-rays. The same order of luminosity was observed with ultra-violet light as with X-rays; and the colour of the fluorescence is similar whether excited by X-rays or by ultra-violet. Crystals of platinocyanides which exhibited yellow and green fluorescence under the influence of the X-rays, behave as bodies opaque to those rays when photographed. Potassium platinocyanide exhibits blue fluorescence, and if a crystal of this salt, separated from the sensitive plate by a sheet of white paper, be submitted to the action of the X-rays, it behaves as a luminous body and does not throw a shadow. The fluorescent light excited by the X-rays in this salt, acts more powerfully upon the sensitive plate than the direct X-rays.

Dr. John Macintyre has sent us an account of a further study and comparison of fluorescent screens. He says:

"I have tried several screens of calcium tungstate as recommended by Mr. Edison. The insoluble amorphous precipitate is fluorescent, but I have had it prepared in the crystalline form from two different sources; in both cases the screens gave much better fluorescence, and consequently better images. Messrs. Baird and Tatlock prepared the one form of crystalline salt, which was larger in the crystals than that prepared for me by Mr. I. Frank Bottomley. As there seems to be some difficulty in obtaining the crystalline form, it may be of interest to say tha the latter gentleman prepared it according to the method of N. S. Manross ("Liebig's Annalen," vols. 81–82). The method consisted in fusing together the anhydrous sodium tungstate and calcium chloride, the latter in excess The sodium chloride and excess of calcium chloride are dissolved out, and crystalline calcium tungstate is left behind to be filtered off and dried. The crystals are a mixture of needles and octahedra, the latter only recognisable through the microscope.

"As far as I have been able to judge from the preparations given to me, potassium-platino-cyanide is the best salt. Of course, Mr. Edison may have a better method of preparing the crystals. With greater experience in screens, I am inclined to think that success depends very largely upon the way in which they are prepared. The paper or glass covering must be thickly and evenly coated. I have had an excellent screen prepared with the barium salt as well.

"My experiments have mainly been with the human skeleton; I have now seen shadows of all the bones and joints of the extremities, and what is more important, by placing the tube in the proper position I have seen distinct shadows of the spinal column and ribs of a man. The head is easily penetrated, and for surgical purposes all we now require in order to obtain greater

definition in any part of the skeleton, is a more powerful source of X-rays; in other words, a step further in the preparation of Crookes' tubes. Even now the shadows obtained are good enough for many surgical purposes."

One of the most important discoveries in the new field of investigation is that certain phosphorescent substances emit rays capable of penetrating opaque materials and producing photographic effects. M. Henri Becquerel's experiments in connection with this matter have formed the subject of several valuable communications to the Paris Academy of Sciences, and have been referred to in our abstracts of the *Comptes rendus*, as well as in a brief note. We propose to give a full account of his work in a subsequent number of NATURE.

Mr. A. Hutchinson has sent us, under date March 23, the following account of experiments carried out by him in the Mineralogical Museum, Cambridge:—

"During the past few weeks I have found that quite a number of inorganic substances fluoresce when exposed to the action of the Röntgen rays; thus the following minerals all become more or less luminous, viz. diamond fluor-spar, apatite, autunite, scheelite, and a number of lead compounds, including cerussite, matlockite, anglesite, lanartrite, phosgenite; also lead chloride, lead iodide, lead glass, uranium nitrate and uranium glass. The fluorescence produced in most of these substances is very weak, but autunite, uranium nitrate and uranium glass, cerrussite, some specimens of fluor spar, and some diamonds become fairly bright. The most effective substance which I have so far examined is, however, scheelite, the native tungstate of calcium. Colourless crystals of this mineral phosphoresce brilliantly under the action of the X-rays, the glow continuing for some seconds after the current is switched off, and when powdered they afford a screen which is at least as bright, if not brighter, than one prepared with barium platinum cyanide. It seems very possible that this substance may be 'the properly-crystallised' calcium tungstate of Edison's telegram, quoted in NATURE of March 19.

"It is, perhaps, interesting to note also that uranium nitrate, uranium glass, and the minerals autunite and torbernite are all capable of producing the remarkable effects discovered by M. Becquerel. Thus I have found that the radiations given out by uranium nitrate, when exposed to daylight, in an ordinary room are capable in twenty-four hours of penetrating sheets of aluminium 0·5 mm. thick, and I have obtained a shadow photograph of a coin by placing it on a plate, thoroughly protected from sunlight by light-tight envelopes, and covering it with a slab of uranium glass. This arrangement was allowed to stand near a window for a day; on developing the plate a distinct outline of the coin was found."

A decided step in advance in the application of Röntgen photography to medical science is marked by illustrations in the current issues of the *British Medical Journal* and the *Lancet*. The former journal contains a striking double-page plate of the skeleton of an infant, reproduced from a photograph by Mr. Sydney Rowland, and demonstrates at once the ability to portray the deep visceral region of the body by means of Röntgen rays. Mr. Rowland remarks that although no disease was present in the body of the child, the picture is none the less interesting from a scientific and medical point of view as being the first step towards the application of the method to the diagnosis of spinal and other deep affections. The photograph was obtained in fourteen minutes, and the age of the child was three months. The tube employed was the new focus tube, and it was placed some eight inches from the surface of the body so as to obtain sufficient spreading to cover the plate. It is pointed out that the positions of some of the soft organs are indicated on the picture; thus the heart and lungs are clearly silhouetted, and curiously enough the coils of intestine; while a clear space above them exhibits the place occupied by the stomach. A striking feature is that only the ossified portions of the bones in the arm and hand produce definite shadows, the undeveloped parts of the bones being but faintly visible.

The *Lancet* referred in the issue of March 21 to a photograph obtained through the body of a dead monkey, into whose kidney a biliary and uric acid calculus had been previously inserted. The current issue contains a plate reproduced from this photograph, and showing the spinal column and ribs with great clearness. The biliary calculus can hardly be distinguished from the kidney substance, but the uric acid calculus shows very clearly. The kidney itself is almost transparent to the rays, though not absolutely so.

In a letter communicated to the *Electrician*, Prof. G. M. Minchin gives a summary of the conclusions to which he has been led with reference to the discharge of electrified bodies by the X-rays. The generally accepted opinion is that the X-rays discharge negative electricity from all bodies with great rapidity, and positive more slowly, leaving every body finally with a positive charge. Prof. Minchin, however, finds that "the X-rays charge some bodies positively and some negatively, and whatever charge a body may receive by other means, the X-rays charge it, both in magnitude and sign, to the charge which they independently give to the body." While gold, silver, copper, platinum and iron are all charged positively by the X-radiation, sodium, magnesium, tin, lead and zinc are charged negatively, the effect being in the case of some of these metals much more marked than in the case of the metals that become positively charged. Antimony appears to be almost neutral. Prof. Minchin considers that these observations tend to support the view that the X-rays are undulatory in character, and not of the nature of kathode rays.

Prof. Oliver Lodge writes to the *Times*:—"It may be worth just putting on record that during the past week I have seen fluorescence excited by Röntgen rays after they had penetrated the bodies of two men standing one behind the other in their clothes. Also, that we have succeeding in radiographing the details of a damaged vertebra in the spine of an adult patient at the Northern Hospital, Liverpool, with an exposure of half an hour; and have found a 'Murphy-button' in the intestine of another adult at the Liverpool Royal Infirmary with an exposure of ten minutes. A 'focus-tube' and a powerful ordinary induction coil were the means used."

Six good photographic reproductions accompany an article on Röntgen photography contributed by Mr. J. W. Gifford to *Knowledge*. One of the pictures of a mouse, and another of a sparrow, obtained on February 28, clearly locate the internal organs.

Finally, a number of important papers are referred to in the abstract of the *Comptes rendus* which appears in another column.

REPORT ON THE USE OF ANTITOXIN IN DIPHTHERIA.

A DETAILED report on the use of antitoxic serum in diphtheria, at the hospitals of the Metropolitan Asylums Board, has just been issued. It exhibits the results obtained during the year 1895 in all the six hospitals in which cases of diphtheria were treated, and is a most valuable testimony to the efficacy of the new treatment. From the summary of the report given in the *Times* we derive the subjoined general statistical results and conclusions.

Antitoxin was administered in rather more than three-fifths of the total number of cases admitted into the hospitals, and those for the most part representing the severer types of disease. The value of results obtained will be seen by taking the whole of the figures for 1895 and contrasting them with those of 1894, or rather with the first ten months of that year, previous to the introduction of antitoxin. This gives the following results:

Year.	Cases.	Deaths.	Mortality per cent.
1894	3042	902	29·6
1895	3529	796	22·5

The reduction in mortality of 7·1 per cent. below that of 1894—the lowest previously recorded in any year—must be fairly attributed to antitoxin, because nothing else was changed in the treatment; the average severity of the disease was about equal in the two years, and the proportion of juvenile, that is unfavourable, patients was somewhat larger in 1895 than in 1894. It may be added that diphtheria in both years alike means diphtheria as clinically, not bacteriologically, diagnosed. The essential conditions, therefore, were the same in the two periods. Had antitoxin been used in all cases in 1895, instead of in three-fifths only, the comparison would have been more symmetrical, but the numbers are sufficiently large to make it quite valid; and in this connection it is worth noting that those individual hospitals which made least use of the drug show the highest rate of mortality and the smallest reduction on their previous records. The broad conclusion reached is that in the year 1895 antitoxin saved 250 lives in London.

A complete examination and discussion of the statistics, leads to the following conclusions:—

The improved results in the diphtheria cases treated during the year 1895, which are indicated by the foregoing statistics and clinical observations, are:—

(1) A great reduction in the mortality of cases brought under treatment on the first and second day of illness.

(2) The lowering of the combined general mortality to a point below that of any former year.

(3) The still more remarkable reduction in the mortality of the laryngeal cases.

(4) The uniform improvement in the results of tracheotomy at each separate hospital.

(5) The beneficial effect produced on the clinical course of the disease.

A consideration of the foregoing statistical tables and clinical observations, covering a period of twelve months and embracing a large number of cases, sufficiently demonstrates the value of antitoxin in the treatment of diphtheria.

It must be clearly understood, however, that to obtain the largest measure of success with antitoxin it is essential that the patient be brought under its influence at a comparatively early date—if possible not later than the second day of disease. From this time onwards the chance of a successful issue will diminish in proportion to the length of time which has elapsed before treatment is commenced. This, though, doubtless, true of other methods, is of still greater moment in the case of treatment by antitoxin.

Certain secondary effects not infrequently arise as a direct result of the injection of antitoxin in the form in which it has at present to be administered, and, even assuming that the incidence of the normal complications of diphtheria is greater than can be accounted for by the increased number of recoveries, we have no hesitation in expressing the opinion that these drawbacks are insignificant when taken in conjunction with the lessened fatality which has been associated with the use of this remedy.

We are further of the opinion that in antitoxin serum we possess a remedy of distinctly greater value in the treatment of diphtheria than any other with which we are acquainted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The next examination for the diploma in agricultural science and practice will begin on July 6, 1896. Names of candidates should be sent to the Registrary of the University on or before Monday, June 22, 1896. The examination is open to persons who are not members of the University as well as to members.

We learn from *Science* that the Bill establishing a National University of the United States has been reported favourably by the Senate Committee. It grants a charter to the University, provides for its government, grants it the ground in the city of Washington designated by President Washington as a site for a national university, and appropriates 15,000 dols. for the fiscal year ending on June 30, 1897, and 25,000 dols. for the year following.

We offer our best wishes to *Education, Secondary and Technical*, the new weekly journal of combined educational interests, which has taken the place of the *Technical World* and *Science and Art*. There is much for such a periodical to do, and the combination of technical and secondary interests in education is certainly one that makes for advancement. As the journal is the official organ of the Incorporated Association of Head Masters, the Association of Directors and Organising Secretaries of County Councils, the National Association of Manual Training Teachers, and the Recreative Evening Schools Association, it should not lack support.

At a meeting of the Technical Education Board of the Stourbridge district, held on Tuesday, March 17, the Chairman announced that promises amounting to £540 had already been received towards the building fund for the proposed new technical schools in that town. Other promises, where the actual amount has not been specified, will materially increase this total. The sum at present assured enables the Committee to claim a grant of £600 from the Worcestershire County Council. It is not intended that a site should be chosen and active steps taken until the sum of £2000 is in hand.

At the meeting of the Association of Chambers of Commerce, held at the Hôtel Métropole, London, on Wednesday, the 25th ult., the following resolution, proposed by the London Chamber, was agreed to :—"That this association views with interest the report of the Royal Commission on Secondary Education, and, while it regrets the exclusion of commercial representation from its membership, suggests that its recommendations be carefully considered, and, so far as they commend themselves, put into practice at an early a date as possible. That the Executive Council be recommended to take an early opportunity of urging upon Chambers of Commerce the necessity of keeping in touch with their local County Councils, in order that such Chambers may secure representation upon any local educational authority which may be called into existence by legislation, and thus obtain the due consideration and provision of industrial and commercial education recognised by the Royal Commission as falling under secondary education."

The Paris correspondent of the *British Medical Journal* reports that the French Senate is about to name a Commission to examine the New University Law, which has been voted unanimously by the Lower Chamber. In the last bulletin of the Minister of Public Instruction of grants, receipts, and register of students in the French faculties during the ten years 1884 to 1895, it is stated that in 1884 a total of 14,000 students were registered in the different faculties, and in 1895 24,000. In 1884 Government granted to the faculties £460,000. In ten years £104,000 has been added, making a total of £564,000. The faculties received from students' fees ten years ago very nearly £160,000, and last year a little more than £260,000. In 1884 each university student cost £21 18*s*. 4*d*. In consequence of the considerable afflux of pupils, the cost to the university for each student is now £11 0*s*. 10*d*. The French universities consider that Government does not treat them with sufficient liberality. In support of their plea the grants to the German universities are quoted; these are £400,000 more than the amount granted by the French Government. No hope is entertained that by Government help the French universities will rival the German universities in organisation of laboratories, libraries, and general excellence.

A strong Committee has been formed to organise some permanent memorial to perpetuate the memory of the late Rev. William Rogers, who did good pioneer work for education. It is proposed that the funds obtained should be used in connection with the St. Thomas, Charterhouse Schools, where Mr. Rogers worked to improve middle-class education, and assisted to develop the present system of elementary education. The introduction into primary schools of the practical study of science and art was commenced there. Dr. Gladstone, F.R.S., in giving evidence before a Special Committee of the London School Board, once said :—"Prof. Sylvanus Thompson told me that the only elementary school in London from which the Finsbury College could draw youths qualified for technical classes, was that of St. Thomas, Charterhouse, where a good deal of scientific instruction is given, and the boys are encouraged to make their own apparatus." The great aim has been to make the institution self-supporting, and this to a great extent has been accomplished; but the providing of special and costly science apparatus—of effecting expensive structural alterations—render it necessary to occasionally apply for extraneous aid, so that Mr. Rogers' work may not be allowed to languish. The late founder, before his serious accident, was intent upon helping the School Committtee to raise funds by means of which the building could be modernised, and a playground added, and additional science accommodation provided. Subscriptions for these purposes, made payable to the account of the Rogers Memorial Fund, will be gladly received by either of the Hon. Secretaries, St. Thomas, Charterhouse Schools, Goswell Road, London, E.C.

Sir John Gorst introduced the Education Bill of the Government into the House of Commons on Tuesday. The Bill is a great measure of educational decentralisation. It provides for the establishment of a paramount educational authority in every county and county borough. This is to be the channel through which public money is to reach the schools. It is to supplement and not to supersede existing educational effort, and it is to be a sort of separate Education Department for each county and county borough. Sir John Gorst also proposes that the education authority shall be the county council acting through a statutory educational committee, and the number and composition of this committee is to be left entirely in the discretion of the county council, subject only to the condition that the majority of its members must be also members of the council. The in-

tention is to decentralise the administration of school grants by the Education Department, and to throw upon those bodies the duty of administering the Parliamentary grant. Should the Bill become law, the general inspection of schools will be undertaken by the county authority, and the Committee of Council—the central government—will only have inspectors who will visit the schools from time to time in order to see that the county education authority is properly fulfilling its duties, and that the education is up to the proper standard. It is proposed to hand over to this committee the powers of the county council under the Technical Instruction Act, 1889. The money received under the Local Taxation Act, 1890, will be specially applicable to secondary education, and will be administered by the education authority, and may be accumulated. It is hoped that the Bill will create a system under which all those parts of a county in which there are public schools will be connected with and under the authority of the county education authority, and will be maintained out of the general county rate. As regards secondary education, the new authority will be able to aid schools out of the money at its disposal and to establish them; and with the assent of the Education Department it may take a transfer from the School Boards of their higher grade schools. The Bill contains numerous proposals which will revolutionise the system of elementary education in this country, and greatly change the positions of Board Schools and voluntary schools.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, March.—Extreme heat in Australia in January 1896. Mr. Russell, Government Astronomer of New South Wales, writes: "We are having a very hot summer. . . . Those who hold that icebergs cool the weather will have a nut to crack with the icebergs on one hand, and these excessive heats on the other." On January 13 the temperature in the shade at Sydney rose to 108°·5. This is the greatest heat recorded there since 1859; the highest previously registered there was 106°·9 in January 1863. A temperature of 108° was also registered in Melbourne, but this temperature had been exceeded on three occasions: in January 1862, the shade temperature reached 111°·1; in 1876, 110°·7, and in the summer of 1882, 110°·5. In some inland parts of Victoria, even higher temperatures were recorded.—Severe frost in North America. Unprecedentedly severe weather has been experienced over the Eastern States of America, and in Newfoundland. On February 17 the thermometer registered 39° of frost at New York, a lower reading than has been recorded so late in the year since observations were begun. In the interior of the State of New York a record of 49° below zero was obtained. In Newfoundland the winter is said to be more severe than has been known for forty years. Snow was lying on the ground to a depth of fifteen feet at St. John's. At Fortune Bay the entire failure of the herring fishery has brought the people to the verge of starvation.

Wiedemann's Annalen der Physik und Chemie, No. 3.—Influence of light upon the form of discharge of an influence machine, by J. Elster and E. Geitel. The brushes and sparks from a Holtz machine passing between a kathode plate of amalgamated zinc and an anode sphere of any metal, are replaced by a glow discharge when the kathode is illuminated with short-wave light. A smaller quantity of electricity passes by this glow discharge than by the brushes and sparks in the dark.—Change of resistance due to electric radiation, by E. Aschkinass. Gratings made of strips of tinfoil have their series-resistance lowered by electric rays. The original resistance is restored by shock or heating. It is most likely that the strips are bridged by free metallic particles, but certain experiments tend to show that the process is molecular rather than purely mechanical.—Interference of electric waves, by Viktor von Lang. This was shown by an apparatus constructed on the plan of that used by Quincke for sound waves. The electric waves enter a tube which divides into two branches, and then recombines. The length of the branches can be adjusted. After recombination the waves impinge upon a Lodge "coherer" which indicates interference by changes of resistance. Well-defined maxima and minima were obtained, and the apparatus was used for obtaining the velocity of the waves in paraffin and in sulphur. The electrical index of refraction was thus found to be 1·648 for paraffin, and 2·333 for sulphur. These values are higher than those hitherto obtained.—Fluorescence of sodium and potassium vapour, by E. Wiedemann and G. C. Schmidt. The vapours of these metals show bright fluorescence when illuminated with bright sunlight. Sodium vapour shows a continuous band in the red, a fluted band in the green, and the bright sodium line in the yellow. Potassium vapour shows an intense red band. These vapours also show electro-luminescence. These results are of importance to astrophysics. The vapours in the solar atmosphere probably owe part of their luminosity to fluorescence, and this kind of radiation would not obey Kirchhoff's law.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 19.—"On the new Gas obtained from Uraninite. (Seventh Note.) Remarks on Messrs. Runge and Paschen's Diffusion Experiment." By J. Norman Lockyer, C.B., F.R.S.

I pointed out in a previous communication (*Roy. Soc. Proc.*, vol. lviii. p. 193) that, from evidence afforded by the behaviour of the lines under different conditions of the spark, the gas obtained from clèveite is in all probability compound.

Some time afterwards (July 11, 1895) Messrs. Runge and Paschen published (*Sitz. der K. Preus. Akad. der Wiss. zu Berlin*, vol. xxxiv., 1895) the same conclusion, and, as a result of a diffusion experiment (Nature, vol. lii. p. 321) described in their paper, they came to the conclusion that the gas giving the line D_3 was heavier than the gas giving the line 5015·7. As they themselves, however, pointed out, the result was not final, because the pressures were not the same. As it is important for stellar classification to settle this matter, I have recently made some experiments in which the pressures remain the same. The experiments are not yet finished, but the first, which was made on January 22, 1896, seems to leave no doubt on one point of the investigation.

An U-tube was taken, and at the bend was fixed a plaster of Paris plug about 1·5 cm. thick; in one of the limbs two platinum wires were inserted. The plug was saturated with hydrogen to free it from air; the tube was then plunged into a mercury trough, and fixed upright with the limbs full of mercury. Into the leg (A) with the platinum wires a small quantity of hydrogen was passed, and as soon after as possible another small quantity of a mixture of helium and hydrogen from samarskite was put up the other limb (B) of the U-tube.

Immediately after the helium was passed into the limb (B), spectroscopic observations were made of the gas in the limb (A); D_3 was already visible, and there was no trace of 5015·7. This result seems to clearly indicate that if a true diffusion of one constituent takes place, the component which gives D_3 is lighter than the one which gives the line at wave-length 5015·7.

Athough this result is opposed to the statement made by Runge and Paschen, it is entirely in harmony with the solar and stellar results. In support of this I may instance that of the clèveite lines associated with hydrogen in the chromosphere, and the stars of Group IIIγ, those allied to D_3 are much stronger than those belonging to the series of which 5015·7 forms part.

Physical Society, March 27.—Prof. Carey Foster, Vice-president, in the chair.—Prof. J. A. Fleming read a paper on the Edison effect. The Edison effect alluded to in the title of the paper is that if a metal plate is placed inside the loop of an incandescent lamp, then a galvanometer of which one terminal is connected to this metal plate, and the other to the positive lead of the lamp, will indicate a current passing from the lead to the plate. If, however, the galvanometer is connected to the plate and the negative lead, no current passes. Prof. Fleming, by connecting the poles of a condenser, firstly to the two leads, secondly to the plate and positive lead, and thirdly to the plate and negative lead, and in each case discharging the condenser through a galvanometer, has shown that after the lapse of a certain time, depending on the position of the plate, if the lamp is working at about four watts per candle, the potential of the plate falls to that of the negative lead. If the plate, instead of being inside the loop of the filament, is outside, then the time taken by the plate to acquire the potential of the negative lead is considerably longer. The space between the plate and the negative lead exhibits a kind of unilateral conductivity, for a battery having a low voltage is able to send a current from the plate to the negative lead, but not in the opposite direction. If instead of using a cold metal plate a second filament, maintained

in a state of incandescence by an insulated battery, is used, then a current can be obtained between this filament and both the positive and negative leads. If the voltage on the lamp is raised considerably above that required to give one candle-power for four watts, then a current can be passed from the plate to the negative lead, while a galvanometer connected to the positive lead and the plate will indicate the passage of a current from the positive lead to the plate. When the lamp is in this condition, the space between the plate and the negative lead is very sensitive to the effects of a transverse magnetic field, such a magnetic field causing a large increase in the resistance. The curve showing the connection between the current passing from the positive lead to the plate and the volts between the terminals of the lamp is found to be discontinuous. As the volts are raised the current suddenly increases about ten-fold, and it is while the lamp is in the condition corresponding to this upper portion of the curve that it is sensitive to the influence of the transverse magnetic field. By using a movable plate it has been found that the minimum current is obtained when the plate is nearer the positive than the negative lead. When an alternating current is used to supply the lamp, a continuous current can be obtained passing from the plate to either of the leads. If a small platinum cylinder is placed surrounding each of the leads, then a current can be obtained between each of the cylinders and the positive lead, but no current between the two cylinders. The largest effect occurs when a cylinder near the end of the negative lead is connected to the positive lead. The author considers that his experiments show that the resistance of a vacuum tube to the passage of a discharge would be greatly reduced if the kathode were made incandescent. Prof. S. P. Thompson said he would like to have some information as to the state of exhaustion of the lamps; whether this was such as is found in ordinary commercial lamps, or whether it more nearly approached that used by Crookes. A great change in the conductivity, &c., took place at an exhaustion slightly greater than that ordinarily found in incandescent lamps. It would be of interest to vary the size of the kathode and to investigate whether the magnitude of the effects observed depended on the fall of potential per unit length along the filament. Another point was whether the position of the plate, for which the effect was a minimum, was the same for all lamps, or whether it changed with the volts and the length of the filament employed. Again, did the minimum occur at a certain fraction of the distance between the positive and negative leads, or, as was the case in some of the phenomena observed by Crookes, at a definite distance from either of the leads. These points might be investigated by means of a lamp with a straight filament where the fall of potential per unit length along the filament might be the same as with the loop-shaped filament, but the fall of potential per unit length in the vacuum would be different. The author's proposed experiment of heating the kathode by concentrating on it the rays of a lamp, did not seem to him (Prof. Thompson) to differ materially from Crookes' experiment in which an incandescent wire, heated by a current, was used as the kathode. Mr. Skinner said that the heating of the kathode by means of a "burning-glass" could easily be carried out. Mr. Blakesley pointed out that it would be quite possible to produce an increase of the current by means of a magnet. Mr. Serle said that Prof. J. J. Thomson had shown that a magnet affected the conductivity of a gas. Prof. Fleming, in his reply, said that no doubt the effects were largely dependent on the vacuum in the lamps. The lamps employed were exhausted to the ordinary commercial vacuum. Since it was found that the "treating" was more worn off the negative leg of the filament, and that a screen placed between the legs of the filament was more blackened on the side turned towards the negative leg, it would appear that the particles of carbon were shot off from the negative leg, and hence perhaps the charge was carried by these carbon molecules.—A paper of a purely mathematical character, entitled "Notes on the electro-magnetic effect of moving charges," by Mr. W. E. Morton, was read by Mr. Serle, who also made some remarks on his own investigations dealing with this subject. The Society then adjourned till April 24.

Geological Society, March 11.—Dr. Henry Hicks, F.R.S., President, in the chair.—On an Alpine nickel-bearing serpentine with fulgurites, by Miss E. Aston, with petrographical notes by Prof. T. G. Bonney., F.R.S. The specimens described were collected on the summit of the Riffelhorn (near Zermatt) by Prof. W. Ramsay, F.R.S., and Mr. J. Eccles, and they showed some very well-marked "lightning-tubes." The rock was a serpentine, somewhat schistose from pressure, which had been formed by the alteration of a rock chiefly composed of olivine and augite. One of the analyses gave 4·92 per cent. of nickel oxide and hardly any lime. Prof. Bonney detected some awaruite under the microscope, but not nearly enough to account for the analysis. Reasons were given to show that the nickel oxide probably replaced lime in the pyroxenic constituent of the rock. The tubes, about $\frac{1}{10}$ inch in diameter, were round in section, cleanly drilled, and lined with a very thin film of dark brown or black glass.—The Pliocene glaciation, pre-glacial valleys, and lake-basins of subalpine Switzerland: with a note on the microscopic structure of Tavayanaz diabasic tufa, by Dr. C. S. Du Riche Preller. The main object of this paper, which was the sequel to one read last session, was to solve the problem whether the Pliocene glacio-fluviatile conglomerates of the Swiss lowlands were deposited on a plateau or in already existing valleys. For the purpose of this inquiry, the author examined last summer a large additional number of glacial high- and low-level deposits throughout the Zürich Valley over an area more than 40 miles in length; and his investigations further led him to important conclusions with respect to the combination of causes which determined the formation of the lake-basins lying in the same zone at the foot of the Alps. He showed that the Lake of Zürich owes its origin, in the first instance, to a zonal subsidence (probably between the first and second glaciation) of about 1000 feet, as evidenced by the reversed dip of the disturbed molasse-strata between the lakes of Zürich and Zug. During the second and third Ice-periods, the original lake-basin was gradually filled with glacial and fluviatile deposits at both ends, and was finally restricted to its present dimensions by a post-glacial bar deposited at its lower end by a tributary river. In the author's view, the other subalpine lakes, extending from the Lake of Constance to Lac Bourget in Savoy, owe their origin and present limits, in the main, to the operation of similar causes. With regard to the main question, he averred that the Lower and Middle Pliocene period was, in Switzerland, entirely one of erosion and denudation on a prodigious scale. Irrespective of the evidence he had adduced, he was therefore driven to the conclusion that at the advent of the first Ice-period in Upper Pliocene times the principal subalpine valleys must have been already excavated approximately to their present depth, and that ever since then the action of the great Alpine and subalpine rivers had been, as it is still in our own day, mainly directed to regaining the old valley-floors by removing those enormous accumulations of glacial and glacio-fluviatile material, which are respectively the direct and indirect products of three successive and general glaciations.—Notes concerning certain linear marks in a sedimentary rock, by Prof. J. E. Talmage. The marks described in the paper occur in a fine-grained argillaceous sandstone referred by the U.S. Geological Survey to the Triassic or Jura-Trias period, which is found on a low tableland within two miles of the bluffs overlooking Glen Canyon. The marks commonly appear as straight lines intersecting at right angles, but some have a pinnate distribution, suggesting engravings of frost-flowers. A description of the markings was given, and various experiments made in the laboratory to illustrate the effects of formation of crystals formed over sediment were described.

Paris.

Academy of Sciences, March 23.—M. A. Cornu in the chair.—On the invisible radiations emitted by the salts of uranium, by M. H. Becquerel. A confirmation and extension of previous experiments upon potassium uranyl sulphate. Uranium salts appear to be unique in the length of time during which they give off photographically active rays in the dark. On comparing the rate of discharge of a gold leaf electroscope by the radiations from a crystal of potassium-uranyl sulphate and a Crookes' tube respectively, the effect of the tube was found to be over one hundred times greater than that of the crystal.—Observations on the preceding communication, by M. L. Troost.—Observations relating to a note of M. C. Henry, entitled "On the principle of an accumulator of light," by M. H. Becquerel. An account of some earlier work on the same subject overlooked by M. Henry.—Application of the X-rays to the diagnosis of surgical diseases, by M. Lannelongue. A description of the results obtained in two cases, in the second of which a supposed exostosis was shown not to exist, the pain and muscular atrophy being due to hysteria.—Researches on the earths contained in the monazite sands, by MM. P. Schützenberger and O. Boudouard.—On the quantities of nitric acid contained

in the waters of the Seine and its principal tributaries, by M. Th. Schlœsing. The amount of nitric acid reaches its minimum about August, and its maximum in February. – Study of the stability of ships by the method of small models, by M. J. Leflaive.—A new property of the surface of a wave, by A. Mannheim.—On groups of operations, by M. Levavasseur.—On a means of communicating to the X-rays the property of being deviated by the magnet, by M. A. Lafay. A bundle of rays from a Crookes' tube was allowed to imprint on a sensitive plate the shadow of a platinum wire supported on a very thin sheet of silver. When the whole was placed in a powerful magnetic field (400 C.G.S. units), the reversal of the current produced a sensible deflection of the image, if the needle was strongly electrified by being placed in connection with the negative pole of the induction coil. If the needle was not electrified, no sensible deflection of the image could be produced.—On the mechanical action proceeding from a Crookes' tube, by M. J. R. Rydberg. On repeating the experiments of MM. Gossart and Chevallier, it was found that the actions observed on the radiometer had their origin in the well-known layer of positive electricity with which the external antikathodic surface of the Crookes' tube is covered during the discharge. By covering the radiometer with a metallic gauze screen, it is possible to take Röntgen photographs through it, without any rotation or mechanical effect being observable.—Origin of the Röntgen rays, by M. Jean Perrin. From the experiments described, the conclusion is drawn that the Röntgen rays are developed only at those points where the kathode rays are arrested, and that this is true whatever material may be used for the tube.—Researches concerning the properties of the X-rays, by MM. Prince B. Galitzine and A. de Karnojitzky. By taking photographs with the rays of tourmalines superposed at various angles, results were obtained showing clearly that with crossed plates the photo-chemical action was reduced. From this the authors draw the conclusion that the X-rays correspond to transversal vibrations.—On the reduction of the time of exposure in Röntgen photographs, by M. G. Meslin. A magnet is used to create a magnetic field perpendicular to the kathode rays inside the tube. A good print of the hand was obtained after twenty-five seconds' exposure.—On the same, by M. Basilewski. A sheet of paper coated with a fluorescent substance is placed between the plate and the object. A photograph of the hand was obtained in ten minutes.—On the same, by MM. A. Imbert and H. Bertin-Sans. A magnet is used to deviate the kathode rays within the tube. Good results were obtained for the hand with exposures varying from one to five minutes.—On the X-rays, by M. Piltschikoff.—On the resistance to the passage of the Röntgen rays of some liquid and solid substances, by MM. Bleunard and Labesse. The study of the coefficients of absorption for saline solutions showed that the opacity increases with the atomic weight of both metal and non-metal.—Action of the X-rays on precious stones, by MM. A. Bugueit and A. Gascard.—Three cases of the surgical application of Röntgen photographs, by M. P. Delbet.—The Röntgen rays in the eye, by M. Wuillomenet.—On a new element contained in the rare earths, of samarium, by M. E. Demarçay. The new element is obtained by fractional crystallisation from fuming nitric acid of the portion of the rare earth rich in samarium.—Action of reducing agents upon the nitroso-compounds of ruthenium, by M. L. Brizard.—On the amalgams of molybdenum and some properties of metallic molybdenum, by M. J. Férée. Amalgams with compositions approximating to $MoHg_9$, $MoHg_2$, and Mo_2Hg_3 are described. The molybdenum obtained by distilling away the mercury from the amalgams is pyrophoric.—On the products of the distillation of wood, by M. E. Barillot.—On isomerism in the aromatic series, by M. O. de Coninck.—On rhodinol and its transformation into menthone, by MM. Ph. Barbier and L. Bouveault.—On the parasite of black-rot, by M. A. Prunet.—On the mode of formation of helicoidal coprolitlis, by M. Léon Vaillant.—On the attribution of the genus *Vertebraria*, by M. R. Zeiller.—On vegetation in an atmosphere vitiated by respiration, by M. L. Mangin.—On two new bacteria of the potato, by M. E. Roze.—On the optical isomorphism of the felspars, by M. F. Wallerant.—On the vegetable and mineral débris of the soundings from the *Caudan*, in the Bay of Biscay, by M. Bleicher.—Oceanographical observations made during the voyage of the *Caudan*, in the Bay of Biscay, by M. J. Thoulet.—On photography through opaque bodies, by M. A. Gassend.

DIARY OF SOCIETIES.

London.

THURSDAY, April 2.

Linnean Society, at 8.—Monograph of the Genus Stemona, Lour: C. H. Wright.—On African Algæ: W. and G. S. West.

Geologists' Association (Waterloo Station), at 4.55.—Excursion to Swanage. Corfe Castle, Kimeridge, &c., ending Tuesday, April 7.

Camera Club, at 8.15.—Cloud Forms and Tropical Weather: Captain Wilson Barker.

FRIDAY, April 3.

Quekett Microscopical Club, at 8.

FRIDAY, April 10.

Royal Astronomical Society, at 8.

Geologists' Association, at 8.

Malacological Society at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Text-Book of Comparative Anatomy: Dr. A. Lang, translated by H. M. and M. Bernard, Part 2 (Macmillan).—Royal University of Ireland, Calendar for 1896 (Dublin, Thom).—Reduction of Greenwich Meteorological Observations. Part 3. Temperature 1841-1890 (London).—Report of the Commissioner of Education for the Year 1892-93, Vol. 1 (Washington).—Outlines of Logic and Metaphysics: J. E. Erdmann, translated by Dr. B. C. Burt (Sonnenschein).—Méthode et Principes des Sciences Natûrelles. Introduction a l'Étude de la Médecine: Th. Funck-Brentano (Paris, Bataille).—The Astronomy of Milton's "Paradise Lost": Dr. T. N. Orchard (Longmans).—The Principles of Sociology: Prof. T. H. Giddings (Macmillan).—Our Country's Butterflies and Moths: W. J. Gordon (Day).—Société d'Encouragement pour l'Industrie Nationale. Annuaire pour l'Année 1896 (Paris).—Le Climat de la Belgique en 1895: A. Lancaster (Bruxelles).—Die Protrophie: A. Minks (Berlin, Friedländer).—Physiological Papers: Prof. H. N. Martin (Baltimore, Johns Hopkins Press).

Pamphlets.—Kosto Komparatibo en Chile del Gas i de la Eliktrizidad, &c.: A. E. Salazar i K. Newman (Santiago).—Energetik und Hygiene des Nerven-systems in der Schule: Dr. H. Griesbach (München, Oldenbourg).—Metric System of Weights and Measures: G. T. P. Streeter (Gee).—Philip's Special Map of the Nile Valley, &c. (Philip).—Philip's Special Large Scale War Map of the Soudan (Philip).

Serials.—Sunday Magazine, April (Isbister).—Good Words, April (Isbister).—Longman's Magazine, April (Longmans).—Chambers's Journal, (Chambers)—Natural Science, April (Rait).—Bulletin of the American Mathematical Society, March (Macmillan).—Humanitarian, April (Hutchinson).—History of Mankind: F. Ratzel, translated, Part 7 (Macmillan).—Journal of the Royal Horticultural Society, March (Victoria Street).—Proceedings of the American Philosophical Society, July (Philadelphia).—Century Magazine, April (Macmillan).—National Review, April (Arnold).—Mémoires de la Section Caucasienne de la Société Impériale Russe de Géographie, livre xvii. livr[n] 1.—Ditto, livre xviii.—Jahrbuch der Meteorologischen Beobachtungen der Wetterwarte der Magdeburgischen Zeitung, Band xiii., 1894 (Magdeburg).—Contemporary Review, April (Isbister).

CONTENTS.

THURSDAY, APRIL 9, 1896.

A LIFE OF LOUIS AGASSIZ.

Life, Letters, and Works of Louis Agassiz. By Jules Marcou. With illustrations. 2 vols. Pp. xxxii + 620. (London: Macmillan and Co., 1896.)

BIOGRAPHIES of Agassiz have not been wanting. In 1885 his widow published a "Life and Correspondence"; in 1893 Dr. F. Holder wrote a "Life and Work," a smaller book, which was reviewed in these pages (NATURE, vol. xlviii. p. 52); while biographical sketches, short and long, are numerous. But in M. Marcou's opinion, to quote from his preface,

"No true life of him has yet appeared: nearly all have been too eulogistic, while, on the other hand, some rather severe strictures and criticisms have incidentally appeared in articles purporting to give the life of some of his associates, or dealing with some special questions of natural history. . . . The true history of Agassiz has not yet been written."

So the task has been taken in hand by M. Marcou, who has executed it in the spirit of the "candid friend," and takes good care that the worshipper, while called upon to notice the gold, shall be in no danger of overlooking any spots of dross in the precious metal of the image. No illusion is any longer possible. We go away convinced that Agassiz was very far from faultless, a man of great strength, with a considerable share of human weaknesses, and that M. Marcou is a very superior person.

Which of the many pictures is the most true, only those who knew Agassiz intimately can judge. It may be permitted, however, to doubt whether his family will feel themselves under an overpowering debt of gratitude to M. Marcou. Granted that he does full justice to Agassiz' genius—his acuteness of observation, his extraordinary memory, his eloquence, perseverance, and powers of work—still he turns the search-light so full on his weaknesses, that they seem almost as prominent as his excellences. But does this serve any good purpose? Some of these weaknesses were inseparable from the nature of the man. Let us grant that he was unbusinesslike in his habits, that money passed through his fingers like water through a sieve, that he was always crying "give, give," even as "the daughters of the horseleech"—was this for his own enrichment, or to serve his own ends? No, it was for the sake of science; the great aim of his life was to procure abundant specimens for study, and, in America, to build up a splendid museum. Granted that he was injudicious in the selection of his assistants, and that his arrangements with them, or rather want of arrangements, sometimes led to trouble—surely the one was an error on the side of a generous trust, the other was pardonable, when the exigencies of the case are considered. How during the stress and poverty of his earlier life could Agassiz have obtained helpers had he not instituted a cœnobite establishment of some kind? How could he make very precise bargains with men to whom he could offer no stipends; who came more as fellow-workers than as assistants? Any one who has read one of the biographies already in existence can see that Agassiz sometimes made mistakes in dealing with his fellows, that he was not a good man of business, and was imprudent, we might say reckless, in matters of finance; but his imprudence was for the cause of science, not to minister to his own ease or luxury. The audacity with which he faced immense difficulties, ran risks that seemed hopeless, and almost courted ruin, if trying to relatives, friends, and even legislators, demands a lenient judgment from those who have profited by his efforts, and who recognise the greatness of his services to science.

There are of course occasions when the saying, *De mortuis nil nisi bonum*, must not be observed, when it is necessary to speak plainly of men whose work is ended. There are faults, about which a biographer cannot be silent—falsehood and treachery, gross selfishness or flagrant immorality. But of these no one can accuse Agassiz. There are times, too, when it is a duty to call attention even to the errors in science which the dead have committed; namely, when a school of this or that prophet is seeking by the glamour of their master's name to paralyse the honest worker and to check the progress of knowledge—but no one has done that wrong to the memory of Agassiz. Posterity, then, does not need that his mistakes should be proclaimed upon the housetops; it knows them already; it is content to be thankful for the good work which he did, and to say, in regard to the bad, "Which of us shall first cast a stone against him?"

But M. Marcou himself has views on scientific controversies, and where Agassiz takes the same side, is not parsimonious in praise. For instance, Agassiz held certain views as to the origin of species opposed to those of Darwin. No opportunity is lost of belittling the latter; a chapter is even devoted to this purpose. We are virtually told that both Darwin and his supporters were more prone to evolve theories out of their inner consciousness than to make careful observations. Here is a sample of M. Marcou's condemnation.

"The most enthusiastic propagators and apostles of the new gospel were not naturalists at all, with the exception of the systematic botanist, Asa Gray. Not one of them was a zoologist, in any sense of the word. Agassiz was too much a naturalist to accept a number of mere suggestions until they were scientifically proved by exact observations."

So we learn, among other pieces of interesting information, that the evidence obtained in the more recent deep-sea dredgings is adverse to Darwin's views as to the origin of species, that had he been right the transmutation of species ought by this time to have been demonstrated by experiment; nay, that even his hypothesis regarding the formation of atolls has been proved erroneous. As to the first, M. Marcou's remarks seem curiously inconclusive; as to the second, they indicate considerable misapprehension of Darwin's views; as to the third, perhaps room still remains for difference of opinion. Darwin's hypothesis as to the origin of species and the origin of atolls may not be "the whole truth and nothing but the truth," but we believe many authorities, quite as respectable as M. Marcou, continue to regard them as at least a long step in that direction. But nothing very good, our censor hints, could be expected from Darwin and his followers.

"Physically Cuvier and Agassiz resembled each other in possessing enormous heads and largely developed

brains, while neither Lamarck nor Darwin were abnormal as regards the size and development of the head. In a crowd Cuvier and Agassiz always attracted attention, and were distinguished at once as uncommonly fine-looking men, while Lamarck, Darwin, and Huxley passed unnoticed."

We will remember Mrs. Malaprop on comparisons, and content ourselves with observing that a crowd in which Darwin and Huxley would have passed unnoticed, must indeed have been composed of remarkable men.

To put the matter shortly, the history of personal squabbles, and the indications of M. Marcou's censorious disposition loom far too large in this book. He cannot let slip a chance of having a fling at somebody, and evidently our nation in some way or other has incurred his displeasure. This, for instance, is how he comments on Murchison's objections to the general applications of Agassiz' views on the extent of land ice: "Precisely what was to be expected from the English geologists, who are always strongly disinclined to accept any new truth, if discovered by foreigners." Considering that for not a little time prior to this date (1840) English geologists had been busily employed in combating mistaken notions—chaotic menstrua, sedimentary basalts, craters of elevation, *et hoc genus omne*—largely manufactured on and imported from the continent, they may be pardoned for some prejudice in favour of home-made scientific goods. Again, in 1846, we are told, as if it were a fault, that Agassiz saw plainly during his short stay in England that "although the English leaders of science were extremely courteous and friendly to him, it was absolutely useless to expect from them the offer of any scientific position." Were they to be blamed? Was not a man so improvident and reckless in money matters as M. Marcou depicts Agassiz, almost sure to be a failure among men with the business-like habits of the English? Would not his trick of occasionally talking brilliant scientific nonsense—we take this also on M. Marcou's authority—have raised doubts as to the solidity of his knowledge among the more phlegmatic British men of science? Was there any reason, at that time, why they should import teachers from the continent? In America things were different; there the study of science was almost inchoate; the workers were few; the generation of men who now can hold their own in every branch of science against the rest of the world, were then at school or unborn. But even an award of the Copley medal to Agassiz calls forth a covert sneer from his biographer—"It was certainly well placed this time"—as though that were not usual.

But enough—the book has its good points; it supplies some *lacunæ* in Agassiz' life, it contains some interesting letters, and it reprints one or two documents not easy of access; notably his *Discours de Neuchâtel* on the Ice-Age, which, however, would have been more fitly placed in an appendix; it gives a very full list of his writings, but—it leaves an unpleasant taste in the mouth. A critical history of Agassiz' work in science, and of his contributions to natural knowledge, would have been valuable. This book is too much occupied by the details of controversies and disputes which few desire to remember, and is too obviously affected by the spirit of a partisan, to fulfil adequately any such purpose.

T. G. BONNEY.

FERMENTATION STUDIES.

Practical Studies in Fermentation; being Contributions to the Life-history of Micro-organisms. By Prof. Emil Chr. Hansen, Ph.D. Translated by Dr. A. K. Miller, F.I.C., and revised by the author. Pp. xiv + 277. (London: E. and F. N. Spon, 1896.)

THE recondite researches of scientific men are usually of too abstruse a nature to tempt their authors to exhume them from the ponderous journals to which they have been committed, and present them to the general public.

With regard to bacteriological investigations, however, the case is different, and the eagerness with which such researches are followed, has justified the appearance of such special works as Prof. Hansen's "Practical Studies in Fermentation," in which a connected account is given of original investigations scattered through divers journals and periodicals.

The appearance for the first time of an English edition of this important work, is rendered additionally welcome by the fact that such an acknowledged authority on the subject as Dr. Miller has undertaken its translation. Hansen's name is now so universally associated with pure yeast culture, that it is difficult to realise that a little more than ten years ago he was fighting his way to obtain permission from Jacobsen, the owner of the Old Carlsberg Brewery, to carry out experiments which have now rendered this brewery famous throughout the world.

Step by step, however, in the teeth frequently of vigorous opposition, Hansen has revolutionised our conception of the practice of brewing, substituting a sound scientific basis for custom hitherto directed by empiricism and tradition.

His researches on yeasts and their systematic selection and classification, have enabled the brewer to guard himself against many of those maladies in beer, which Hansen was the first to show were not necessarily attributable to bacterial contamination, but were directly dependent upon the presence of so-called wild yeasts, whilst the substitution of pure yeasts for the heterogeneous mixture previously in use, has, in his own words "helped to raise the industry, a point of great interest to the intelligent brewer."

Naturally after the identification and classification of yeast species, the next step is their successful preservation. This Hansen has found is most effectually carried out in ten per cent. solutions of cane-sugar, and so-called "stock" yeasts can be retained in this manner for upwards of fourteen years without suffering any detriment, and can be propagated at will in beer wort, and sent all over the world. Ingenious methods have been devised for the transport of yeast, and so successful have been the results, that yeast samples have been sent by Jörgensen and others from Copenhagen to South America, Asia, Ecuador, and Australia, without any deleterious effect being produced.

It would not be within the scope of the present brief notice to enter into any detailed description of the numerous and varied problems in connection with yeast fermentation which Hansen has so patiently and successfully attacked; but to the bacteriologist the discussion of the diseases of beer produced by alcoholic ferments

will doubtless prove of special interest, giving, as it does, a concise account of the history of researches commenced over a hundred years ago, which prepared the way for the advent of Pasteur, and which have conducted Hansen on to his special line of investigation.

Of great importance in all bacteriological researches is the individuality of bacteria and the variations which may be introduced by suitable means in their morphological and biological character. But whilst the impressionable nature of bacteria renders their education so particularly attractive, it also complicates in divers ways their successful investigation. Now Hansen has been led to devote a great deal of attention to the variations which are inducible in yeasts, in consequence of the suggestion that the disease yeasts, so undesirable to the brewer, may in reality only be degenerate forms of the true brewery yeasts, and that, therefore, the introduction of pure cultures cannot ensure the absence of these malignant forms. But Hansen states that although he has studied for many years the cultivation of pure yeast on a large scale, he has never seen any signs of the brewery yeasts developing forms like those characteristic of disease yeasts, that on the contrary, under the conditions obtaining in the brewery, they always retained their specific character; and he concludes by saying, "the theories of the degeneration and transformation of yeast have thus, in this respect, proved to be quite untenable."

Yet irregularities do occur in the brewery yeast itself which cause great annoyance to the brewer, and in most cases there is no clue to their cause.

That yeasts, like bacteria, are capable of artificial modification, has been repeatedly shown by Hansen. Thus he found that yeast grown in aërated wort behaved normally in the brewery as regards clarification and attenuation, whilst that grown in non-aërated wort lost, for a time at least, these functions. Again, on submitting a yeast, *Sacch. Pastorianus I.*, to particular conditions, it completely lost its power of forming spores, whilst at the same time its capacity to produce films in old wort cultures disappeared.

It is obvious of what great importance is an intimate knowledge of the conditions which are able to modify the character of yeast cells, for, even with pure cultures, the brewer is yet unable to perfectly manipulate the working of his yeast, although the elimination of unfriendly varieties has materially lightened his difficulties.

Recently the old question has been revived by Juhler and Jörgensen as to the origin of yeast cells, and it is yet a question to which we have no final answer whether they are to be regarded as independent organisms, or only forms of development of the higher fungi. Fifty years ago the latter view was held by Bail, Hoffmann, and others, but at present Juhler's and Jörgensen's observations on the development of yeast cells from the *Aspergillus oryzæ* have not been confirmed, for Klöcker and Schiönning repeated their experiments, but failed to observe the development of yeast cells.

Until we shall be in a position to trace out the parentage of yeast cells, we cannot aspire to arrive at a complete understanding of the conditions which determine their individual characteristics. The same difficulty faces the student of bacteria; whether the differences, sometimes so slight, but, as far as our means of observation at present extend, apparently quite constant between otherwise such similar forms of bacteria, are fundamental or produced from the same form by conditions of which we have no knowledge, is still one of the problems of which we have no satisfactory solution.

Just as Hansen has been able to present us with a form of yeast from a spore-producing parent which will not form spores, so, for example, Roux has introduced us to sporeless anthrax; whilst in bacterial fermentations, Percy Frankland has shown that by suitable treatment the progeny of a fermenting organism can be made to yield up its power of fermenting particular solutions, and that only by resorting to special treatment can its fermentative powers be restored to it.

In the case of the sporeless yeast, and sporeless anthrax, and the non-fermenting bacteria, it would be impossible, on casually meeting with them without a previous acquaintance with the facts, to avoid regarding them as different species of yeast and bacteria from the familiar spore-producing yeast, and anthrax, and fermenting bacteria respectively, yet we know as a fact that they are in reality but variations from the parent form in each instance.

It is obvious, therefore, how important is a knowledge of the pedigree of these minute particles of living matter to enable us to rightly appreciate their character, reckon upon their conduct, and determine their claims to be regarded as separate species.

Prof. Hansen is at present engaged in preparing a special account of his researches on these variation phenomena in yeast, and the conditions which control them; and the work cannot fail to prove of great importance not only to the practical brewer, but to all interested in the study of micro-organisms.

PALÆONTOLOGY AT THE BRITISH MUSEUM.

Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Nat. Hist.). The Wealden Flora. Part II. *Gymnospermæ.* By A. C. Seward, M.A., F.G.S.. 8vo. Pp. xi + 259; pl. 20, and 9 illustrations in text. (London, 1895.)

Catalogue of the Fossil Fishes in the British Museum (Nat. Hist.). Part III. *Containing the Actinopterygian Teleostomi of the orders Chondrostei* (concluded), *Protospondyli, Ætheospondyli, and Isospondyli* (in part). By A. Smith Woodward, F.G.S. 8vo. Pp. xlii + 544; pl. 18, and 45 illustrations in text. (London, 1895.)

THESE two catalogues, the last additions to the long series of palæontological monographs published by the Geological Department of the British Museum, testify to the value of the work there done under the supervision of Dr. Woodward. The two volumes illustrate, moreover, the strikingly different points of view from which palæontological problems are regarded. Mr. Smith Woodward's catalogue is zoological in its aims and methods, while in Mr. Seward's, though the methods are biological, the most generally interesting results are geological.

The first volume of Mr. Seward's catalogue of the Wealden plants described the Algæ, Characeæ, Equisetinæ, and Filicinæ; the present volume concludes

the account of the flora of that period, by the description of the Cycads and Coniferæ. The complete absence of Angiosperms from the Wealden is disappointing and surprising, for it was unquestionably at that period that the higher flowering plants were evolved. Both in the Potomac beds of America and in rocks of the same age in Portugal, there are remains of monocotyledons and dicotyledons. Angiosperms have been also recorded from the Wealden; but Mr. Seward, after a careful consideration of the evidence, dismisses it as invalid. Mr. Seward's catalogue contains a full description of all the known plants from the Wealden series, and he is to be congratulated on having expanded his catalogue into a complete monograph of the whole flora, which numbers seventy-six species. The present volume contains the description of twenty-four Cycads and seventeen Conifers, of each of which as full an anatomical account is given as the material allowed; the genera are discussed in detail, and important additions made to the knowledge of their structure and affinities, as in the case of *Otozamites* and *Bennettites*. Mr. Seward gives a full bibliography. He discusses the relations of the British flora to their foreign representatives, their geological position, and their evidence as to the climatic conditions under which they lived. His conclusions on these subjects are of great interest. He says the climate was apparently tropical, and that the temperature must have been considerably warmer than that which rules in the Wealden district at the present day (p. 239). It is barely necessary to point out, that geologists have always included the Wealden deposits in the Cretaceous; but Mr. Seward tells us that "the evidence of palæobotany certainly favours the inclusion of the Wealden rocks in the Jurassic series." This conclusion is in accord with that of other lines of palæontological evidence, and it may be hoped that Mr. Seward's pronouncement will hasten the inevitable dismemberment of the Wealden series into two groups, the equivalents respectively of the Neocomian and Portlandian series.

If we miss in Mr. Smith Woodward's catalogue the geological conclusions which render Mr. Seward's so interesting, it is certainly superior to it in one respect; viz. the conciseness, and precision of the diagnosis of orders, families, genera, and species. In such catalogues we too often only have the synonymy and indefinite descriptions of specimens, instead of definite, accurate diagnoses. In this respect Mr Smith Woodward's work is a model. The arrangement is strictly zoological, and thus the volume will be mainly of interest to students of icthyology. The main task of the volume is to trace the gradual evolution in the Actinopterygi from the lower Chondœstrean type to that of fish which approximated to the Teleostei. Mr. Smith Woodward describes the successive modifications of the Mesozoic fish fauna, whereby this evolution has been effected. His classification therefore represents, not an *à priori* scheme as to the probable life-history of the fauna, but an actual life-history as revealed by the records of the rocks. In groups of animals where the fossil remains are sufficiently abundant to enable this to be done, this is the ideal system of classification. Mr. Smith Woodward introduces such revolutionary changes into the families and orders, that he has been obliged to abandon the attempt to show the relations of the divisions he accepts, to those of his predecessors, by synonymic tables. The author is greatly to be congratulated on his treatment of such genera as *Acipenser*, *Amia*, and *Lepidosteus*. As members of these genera still survive, they can be dissected and their anatomy studied in detail. Hence it has been the custom to take them as the types of the Chondrostei, Protospondyli, and Ætheospondyli respectively. But as these living genera are only degenerate, or at least remarkably specialised forms, they give a very misleading idea of the typical members of the Actinopterygi. Mr. Smith Woodward, therefore reduces them to their proper position, as aberrant offshoots from the main stem. This volume is a bulky one, and it is impossible in a brief abstract to give any idea of the amount of new information it contains. The anatomical structure of each genus is carefully worked out, so that the systematic conclusions are based on morphological characters. Many of the more important genera are also illustrated by restorations, while the series of diagrams of the cranial osteology are most instructive.

Reference must also be made to the thirty-eight clear and artistic plates, which have been drawn by Miss G. M. Woodward for the two catalogues.

OUR BOOK SHELF.

The Hymenoptera Aculeata of the British Islands. A Descriptive Account of the Families, Genera, and Species indigenous to Great Britain and Ireland, with Notes as to habits, localities, habitats, &c. By Edward Saunders, F.L.S. 8vo. Pp. viii + 391. (London: Reeve and Co., 1896.)

A GREAT number of books are published at presen relating to the more popular orders of insects, especially British butterflies and moths. Some entomologists, however, devote their attention to the more varied fauna of warmer climates, and publish valuable monographs on the insects of Central America, Asia, or Africa. We are glad to find that others make the less fashionable, if equally interesting, orders of British insects their study; and although there are still many groups, and even whole orders of British insects of which we do not at present possess any trustworthy monograph, their number is lessening year by year. Mr. Saunders deserves special praise for his labours in this direction. After publishing one or two useful works on foreign insects, he turned his attention exclusively to British entomology. He has given us a work on British *Hemiptera*, which is to be followed by one on British *Homoptera;* while the book before us relates to the British *Hymenoptera Aculeata*, the section of the vast order *Hymenoptera* which includes the bees, wasps, and ants, in which the ovipositor is usually modified into a sting in the females, though in some families, as in the first family of ants, the typical *Formicidæ*, the insects do not sting, though some of them bite very severely.

It is not the first time that Mr. Saunders has dealt with the *Hymenoptera*. Synopses of the British Aculeata were published in the *Transactions* of the Entomological Society of London some years ago, in addition to important papers on structure; and the former, enlarged and brought down to date, have formed the basis of the present work. He regards the *Hymenoptera* as entitled, both by their intelligence and structure, to stand at the head of the insect world; and they reach their highest development in the *Aculeata*, which, at present, number 374 British species. Full characters of species and genera are given, including elaborate tables of species. Three

plates of structural details have been added, two of which are devoted to the structure of the mouth in the principal genera of bees. The first, however, which includes details of general structure, very carefully indicated, will prove of the greatest value to entomologists taking up the study of the order *Hymenoptera*. There is a larger edition of the work, with coloured plates of the various species; but of these we cannot speak, as they are not before us while writing. We hope that Mr. Saunders' labours may induce many residents in the country to take up the study of the order *Hymenoptera*, and ultimately to extend their researches beyond *Aculeata* to the far larger and much more neglected, though hardly less interesting, section of *Terebrantia*, which includes the sawflies, gallflies, ichneumons, &c. The parasitic groups are so numerous as to render the *Hymenoptera* probably the largest of all the orders of insects, though they have hitherto received far too little attention from British entomologists.

Ostwald's Klassiker der exakten Wissenschaften, Nos. 67 to 75. (Leipzig: Wilhelm Engelmann, 1895–96.)

We have before us nine volumes recently added to Prof. Ostwald's very handy and useful series of reprints and German translations of classical papers. No. 67 is A. Göpel's "Theoriæ transcendentium Abelianarum primi ordinis adumbratio levis," published in 1847. This is edited by Dr. H. Weber, and translated into German by Dr. A. Witting. No. 68 should be of interest to chemists, for it contains papers by Lothar Meyer (1864–69) and Mendelejeff (1869–71) on the "Natürliche System der chemischen Elemente." This volume is edited by Dr. Karl Seubert, who adds to it some notes on Newland's work in connection with the discovery of the periodic law. A translation of Maxwell's papers on Faraday's lines of force, read before the Cambridge Philosophical Society in 1855–56, appears in No. 69 of the series, edited and annotated by Prof. Boltzmann. The following volume (No. 70) is taken up with Seebeck's papers (1822–23) on "Magnetische Polarisation der Metalle und Erze durch Temperatur-Differenz," its editor being Dr. A. J. v. Oettingen. No. 71 contains Abel's investigations of the series

$$1 + \frac{m}{1}x + \frac{m(m-1)}{1 \cdot 2}x^2 + \frac{m(m-1)(m-2)}{1 \cdot 2 \cdot 3}x^3 + \ldots$$

published in Crelle's *Journal* in 1826. In the volume entitled "Chemische Analyse durch Spectralbeobachtungen" (No. 72), Kirchhoff and Bunsen's contributions to spectrum analysis in 1860 are reprinted, with two coloured plates and seven figures in the text. The editor of this volume is Prof. Ostwald. Under the title "Zwei Abhandlungen über sphärische Trigonometrie" (No. 73), translations, by E. Hammer, are given of two papers by Euler—one on the outlines of spherical trigonometry (1753), and the other on general spherical trigonometry (1779). In No. 74, German readers have provided for them a translation of Berthollet's discussion of the laws of affinity (1801), edited by Prof. Ostwald. Finally, Prof. Groth edits a German edition of the work of the Finland mineralogist, Axel. Gadolin, on the "Herleitung aller krystallographischer Systeme mit ihren Unterabtheilungen aus einem einzigen Prinzipe," which forms No. 75 of this valuable series. Our only regret is that English readers have not a similar collection of edited reprints and translations of scientific classics.

The Metric System of Weights and Measures. By G. T. P. Streeter, B.A. Pp. 43. (London: Gee and Co., 1896.)

This short treatise is not only concerned with the metric system, but also contains "certain arithmetical principles, problems and formulæ, and an appendix on the common chemical reactions." The arithmetical contents may be useful as a supplement to ordinary books on arithmetic, but the statement of chemical reactions is "cram," pure and simple.

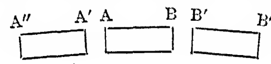
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Stress in Magnetised Iron.

Mr. Wilberforce's letter (Nature p. 462) raises some points I ought to notice. In treating of the stress and strain, my phraseology has, I think, been extremely "unmaterialistic," in the sense that I have said little or nothing about a magnetic "ether," and have employed rather the language of action at a distance. Maxwell doubtless would have put things very differently, but my own experience has been that when one wishes to avoid confusing ordinary people on such questions as the sign of a stress or strain, the less one says about "ether" the better. My discussion of Maxwell's electrostatic medium (*Proceedings* Edinburgh Math. Soc., vol. xi. p. 107) will show, I hope, that his standpoint is not unfamiliar to me. The question really at issue is the existence and sign of certain strains in *iron* and other gross materials, and I judged Prof. Ewing's mode of presenting the case, which I practically followed, to be as clear as any. If strict Maxwellians object to the association of his name—which I did not originate—with stresses answering to the strains in question, by all means let us use another term, say "Q stresses," so long as their existence is queried.

In the accompanying figure—slightly modified from that on p. 270—suppose for the moment A'' A', AB, &c., to be straight lines. The conclusion I reached that the stress on the element AB of a uniformly magnetised bar, with air gaps AA', BB', is a *tension* meets, I am glad to see, with Mr. Wilberforce's support. This



implies his belief that the reasoning of Mr. Shelford Bidwell (*Phil. Trans.*, 1888, pp. 216, 217), Prof. Ewing ("Magnetic Induction," § 145), and Dr. More (*Phil. Mag.*, October 1895, pp. 349, 350)—who in the places cited have treated the existence of air gaps as immaterial—should have led them to the conclusion that "Q stresses" exist, and that they cause a *lengthening*, not a shortening, of magnetised iron.

Mr. Wilberforce's reconciliation of Prof. Ewing's present views with my own is based, I rather fear, on a fallacy. Let us consider the accompanying figure, still supposed to represent a straight uniformly magnetised bar.

When gaps AA', BB' exist, there must, as Mr. Wilberforce says, be forces at A'', B'' to balance the attractions exerted by AB. Let, however, A' move up to A, and B' to B, and equilibrium will still exist when the forces at A'', B'' are supposed to be reduced to zero. Hence, Mr. Wilberforce argues, in a continuous bar the "Q stresses" at A and B cease to exist. Let us push the argument a little further. Equilibrium will still exist when equal pressures of any magnitude are applied at A'' and B'', so that apparently the conclusion to be deduced is that the "Q stresses" are pressures *wholly arbitrary in magnitude*, which Euclid, I fear, would have declared to be absurd.

The explanation of the paradox is, I think, that when we treat A' A'', B' B'' as finite, we must suppose the conditions such as to maintain unaltered the state of uniform magnetisation originally postulated, and this does not leave the magnetic stresses at A'' and B'' arbitrary. We may of course use a magnetic bar for transmitting stresses other than the "Q stresses." For instance, if we employ two magnetising coils, carried by the bar itself, their mutual attraction or repulsion will introduce stress into the bar. (This is, I think, analogous to the case of glass and tinfoil introduced by Mr. Wilberforce.) All such stresses must be allowed for, but I think it is expedient when possible to avoid confusing them with the "Q stresses."

Mr. Wilberforce seems to me to attach too much importance to the criterion of equilibrium. The equilibrium of the element AB in the figure would be equally secured whether the stresses transmitted across the air gaps were pressures or tensions.

My illustration of the rotating anchor ring was introduced because Prof. Ewing seemed unable to realise the existence of a uniform stress—whether tension or pressure—in a simpler system than that composed of an outer hollow ring pushing or

pulling, and a connected inner ring pulling or pushing. I do not myself see that the existence of acceleration—in the strictly mathematical sense—in a ring rotating with uniform angular velocity is any real disadvantage; but if Mr. Wilberforce thinks it is, then as an accomplished and not too materialistic mathematician, he will, I hope, be satisfied with the case of a ring formed of matter repelling as, say, the inverse square of the distance.

Judging by what has passed, I think an attempt to put clearly the problem as it exists in a magnetised ring may be of service. Suppose the diagram on the preceding page to represent 3 out of, let us say, 360—or any larger number deemed requisite to justify treating arc and chord as practically identical—equal elements of a ring. When unmagnetised suppose each to be of length l, and to be separated from its neighbours by extremely small air gaps of width λ. The elements may be supposed to lie on a smooth horizontal table. When uniformly and equally magnetised each element will change in length, let us suppose lengthen, by the same amount δl. This lengthening is due presumably to several causes; of which one is the tension which experiments by Dr. Taylor Jones and others have shown to be nearly $B^2/8\pi$, so long as the permeability is large. For shortness, I shall treat this tension as actually $B^2/8\pi$ up to actual contact. The contribution to δl due to this stress may be taken as $B^2l/8\pi E$, where E is an elastic modulus, which, strictly speaking, varies with B. Suppose now B so chosen that $\delta l = \lambda$, so that the width of the air gaps reduces to zero. Then Mr. Wilberforce's view would seem to be that at the instant the gaps close the stress producing the lengthening $B^2l/8\pi E$ becomes zero, and comes into existence again only when the consequent shortening of the elements reopens the gaps; in this way a species of oscillation would ensue. Prof. Ewing, I rather fancy, would suppose the stress to exist until there is absolute continuity of matter. To deal with either view, suppose that at the first instant of contact, by some process of welding which leaves the material unaltered, the 360 elements transform into a solid ring. Call the state just before welding M, and that when equilibrium has ensued after welding N; then the following views seem to be or have been held:

(1) (By Mr. Shelford Bidwell, Dr. More, and Prof. Ewing [originally]) that the ring in N is shorter than my reasoning makes it in M by $2 \times (360\ B^2l/8\pi E)$.

(2) (By Prof. Ewing [now] and Mr. Wilberforce) that the ring in N is shorter than in M by $1 \times (360\ B^2l/8\pi E)$.

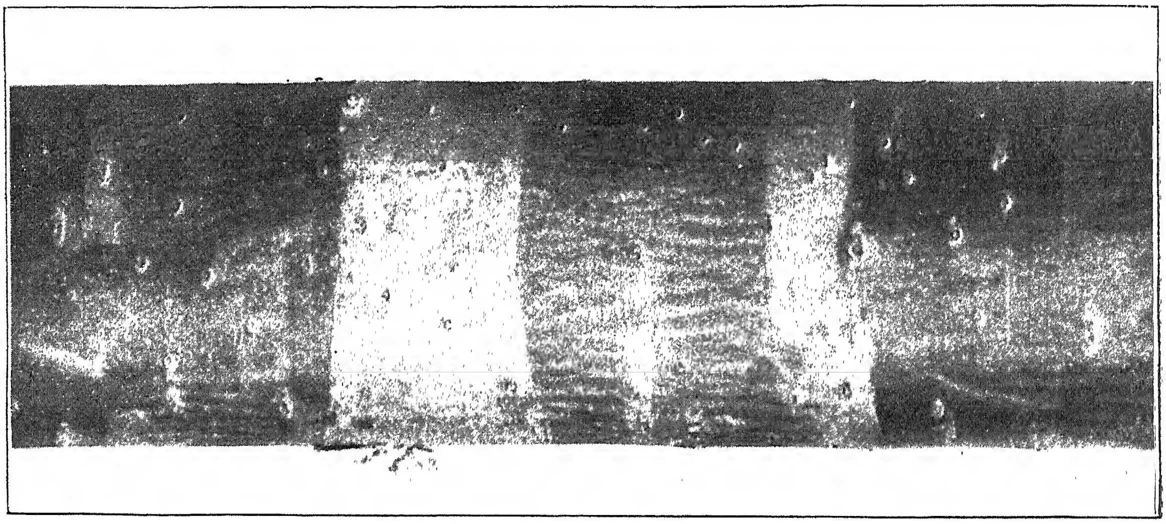
(3) (By, I believe, Prof. J. J. Thomson, Dr. Taylor Jones, and myself) that the ring in N, if shorter than in M, is so by a less amount than $1 \times (360\ B^2l/8\pi E)$. CHARLES CHREE.

March 23.

The Sacred Tree of Kum-Bum.

REFERRING to the letter of Mr. W. T. Thiselton-Dyer, you have published under the title "The Sacred Tree of Kum-Bum" (March 5, 1896, p. 412), I may add that Dr. Kanitz (as I am told by Dr. S. Bretschneider) identifies the tree as the *Ligustrina amurentis*. With the permission of the Vice-President of the Imperial Russian Geographical Society, I send you herewith a photograph (natural size, untouched) of about two-thirds of the piece of the stem of that tree in possession of the I.R.G.S., which received the piece from a lama who visited Kum-Bum late in the autumn of 1894.

The wood is very light, the bark thin (the diameter of the piece being 46 × 47 on one end, 45 × 46 millimetre on the other; the thickness of the back does not exceed 1 millimetre, being the third of it in some places of the circumference), its surface is somewhat rugged, as from desiccation (to be seen on the photo), the outer tissue is grey, translucent, the colour of the bark reddish, the signs *in* it of a golden hue, and can be discerned through the epiderm, but are best seen when the latter is pulled off.



Natural size in breadth, about two-thirds in length, of the piece in possession of the Imperial Russian Geographical Society, St. Petersburg.

A. GRIGORIEV,
Secretary of the Imperial Russian Geographical Society,
St. Petersburg.

A Jamaica Drift Fruit.

IN connection with the article by Dr. Morris on a Jamaica drift fruit, which appeared in NATURE of November 21, 1895, I am able to supplement it by a record of the tree in Trinidad. On March 10, after a personal visit to the vicinity, I despatched Mr. Lunt, my assistant—who may be remembered as being attached to Mr. Bent's expedition to the Hadramaut—to search for the tree or trees stated to have been seen by Messrs. Crueger and Devenish. I am glad to say that I have now Mr. Lunt's report on the trip before me, and still better, I have specimens taken from the trees, which show that *Saccoglottis amazonica* may still be regarded as one of our forest trees. Mr. Lunt followed as directed the course of one of the rivers, and found the tree in more than one place. He was able to bring fresh fruits, leaves and buds, but no flowers were to be had. Mr. Lunt notes that the specimens brought show that the fleshy outer layer or sarcocarp is not, as has been supposed, worn away by water, but owing to its palatable character forms the food of numerous fruit-eating animals, and that on falling to the ground it is further cleaned by ants.

It appears that after the sarcocarp is eaten away the seeds rest upon the ground until the occurrence of heavy floods, when they are washed away by the currents.

The sarcocarp is very pleasant to the taste, and is to be compared very closely with the exterior of many species of the genus Pyrus—as far as I could judge from the single specimen brought home in the green state.

Abundant fresh seeds deprived of the sarcocarp were procured, and a dissection of these shows how accurate are the drawings of Crueger, which were produced in Dr. Morris's article. We hope to secure full sets of herbarium specimens later.

J. H. HART.

Royal Botanic Gardens, Trinidad, B.W.I.

The Rotation-Period of Venus.

DURING the years 1876 and 1878 I paid some attention to Venus at the Kempshot Observatory, and although no distinct markings on the disc were seen in the very small equatorial, yet the following observation may prove valuable:—"1876 October 2, 6 a.m. The planet dichotomised, but the terminator is not straight; the S. horn projects, and the N. horn is rounded off."

By comparing the sketch then made with the drawing, Fig. 1, in the article in NATURE of February 20 (p. 367), there can be no doubt that the broader features in the curvature of the terminator are the same in both. Fig. 1 was taken from a drawing by Signor Mascari, October 12, 1892, or about sixteen years after mine.

Now every eight years the earth and Venus come to nearly their same position again in their respective orbits, for 365·24d. × 8 = 2921·9d., and 224·7d. × 13 = 2921·1d.; and consequently if the rotation-period of Venus be 224·7d., any well-marked permanent feature will become visible every eight years.

The question is whether this curvature of the terminator will prove to be a permanent feature or not under the circumstances detailed above; and for the answer we shall have to wait until the western elongation of Venus in September or October 1900, when observations made at or a little after the time of dichotomisation will show whether the agreement of the drawings in October 1876 and 1892 was a mere coincidence or not.

Jamaica, March 14. MAXWELL HALL.

A Remarkable Meteor.

MR. BACKHOUSE'S observation of the beginning of flight of the slow-moving meteor of March 1 appears to have been from a point 2° south-east of α Canis Minoris instead of between α and β of that constellation, as I at first assumed from the description. This misunderstanding shows the extreme importance of noting meteor tracks according to the best method, viz. that of giving the R.A. and Decl. of the beginning and end points. This is at once simple and effective; it avoids the frequent errors which occur when projecting meteor tracks from descriptions (sometimes ambiguous) of their courses by the stars, and saves endless trouble.

A reinvestigation of the path of the meteor shows it to have commenced its visible career when nearly over York at a height of 55 miles, and it was last seen by the observer at Sunderland when 53 miles high. Mr. Clark at York, however, watched it much further, and after it had passed over Heligoland when its height had again increased to 55 miles. The radiant was nearly on the western horizon, and the meteor, which in the early part of its flight was descending towards the earth, showed a slight ascent towards the end. The average velocity from the two estimates of duration seems to have been about 20 miles per second.

An observation from Kiel or Hamburg would be very useful for comparison, as the meteor at its terminal stages was comparatively near those places, and must have been far more brilliant than it appeared from York and Sunderland.

Bristol, April 3. W. F. DENNING.

Simple Huyghens' Apparatus for the Optical Lantern.

IN his excellent handbook on experimental optics, "Light," Mr. Lewis Wright describes and figures the well-known double-image phenomena to be observed when an ink-dot is viewed through two superposed rhombs of calc-spar. He does not suggest, and I have not seen elsewhere the suggestion, that the experiment is readily adapted to lantern projection. This, however, is the case, and when so projected this experiment is more useful to the demonstrator than that of the double-image prisms, commonly known as Huyghens' experiment, since the apparatus is more simple. There is no colour correction to explain—nothing to occupy the mind of the student but the action of the spar.

My method is to take two small rhombs of a thickness of 1½ inches or more, and mount them near together in such a way that one or both can be rotated. I use by preference a small parallel beam from the parallelising lens, and between this lens and the rhombs, close to the latter, is placed a thin metal plate having an aperture of a size depending on the thickness of the rhombs. The thicker the rhombs the larger, of course, can be the aperture. The rays, after passing through the pieces of spar, are focused by the ordinary objective so as to give sharp images of the aperture in the plate. Rhombs can often be found whose cleavage faces are quite perfect enough to allow sharp images.

It is evident that a single rhomb in the position here indicated may be made to serve nearly or quite all of the purposes of the double-image prism—may sometimes, indeed, to the advantage of the demonstration, replace the analysing Nicol. This fact has its obvious usefulness in the present scarcity of Iceland spar.

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THE MANAGEMENT AND PROTECTION OF FORESTS.[1]

II.

THE working plan of coppice woods is a simple matter. The area is divided into as many compartments as there are years in the rotation. If the coppice is cut, when it has attained the age of fifteen years, fifteen compartments are formed, and every year the old wood on one compartment is cut, after which the coppice shoots grow up to form the new crop. The rotation is determined by the species composing the coppice, and the class of material required, and the yield depends upon the areas cut over, which are equal, where the quality of the locality is uniform, unequal in inverse proportion to the quality, where the quality varies.

In the case of high forests, matters are more complicate, and a brief indication of the main subjects that must be attended to, may serve to explain what is done. A thorough examination of all portions of the forest, its previous treatment, soil, climate, and other conditions, which influence the growth of trees, an accurate and detailed survey of the growing stock, and, lastly, the market for timber and other produce, and the labour available for forest work, are the points which must be examined in the first instance. The next subject is the study of the lines of communication, roads, and water-courses to be used for the transport of timber; and, lastly, the subdivision of the forest into blocks and compartments. A forest to be manageable must consist of compartments of moderate and fairly uniform size. On level ground regular rectangular figures are most convenient; in a hilly country, compartment boundaries must follow the configuration of the ground. Obviously it is in every respect convenient that, wherever practicable, compartment boundaries should coincide with export roads; the sooner, therefore, a system of roads is projected and traced on the ground the better, the traces serving as compartment lines, though the roads need not be built until cuttings are made in the compartments adjoining them.

Simultaneously with the division of the forest into blocks and compartments, the method of treatment must be considered, the choice of species, and the sylvicultural system, particularly with regard to the regeneration of the forest, and the arrangement of cuttings. Large forest areas will generally have to be divided into several working sections, each with its own system of treatment—say one working section for coppice woods,

[1] "A Manual of Forestry," by William Schlich, C.I.E., Ph.D. Vol. iii. (pp. xix + 397). "Forest Management," by William Schlich. Vol. iv. (pp. xix + 593). "Forest Protection," by W. R. Fisher, B.A. (London: Bradbury, Agnew, and Co., 1895.) (Continued from p. 515.)

another for coppice under standards, a third for high forest of spruce or Scotch pine, worked on short rotations, with clear cutting and planting; others, again, for high forest worked on a long rotation, under the selection and shelter-wood compartment systems.

Two prominent points to be settled in a working plan are to determine the rotation and the annual yield. As regards the rotation—that is, the age at which the timber should be cut—the requirements of the market must be consulted in the first instance. It has already been mentioned, that where pit-props find a ready market, coniferous woods may profitably be grown on a short rotation of 50 to 70 years. Where building wood of moderate dimensions pays best, a rotation of from 80 to 100 years will be more profitable. Oak timber, on the other hand, takes a long time to attain a marketable size, and afterwards, with advancing age and increasing diameter, continues long to increase in value. Where it is intended to regenerate forests by self-sown seedlings, trees must of course be allowed to attain that age at which they bear good seed in sufficient quantity; nor must they be allowed to remain after the production of good seed has diminished.

These considerations follow as a matter of course. A more difficult question is, within these limits, to decide upon the most suitable rotation. It might be thought that the simplest plan would be to divide the total income expected during the rotation, less the expenses incurred, by the number of years in the rotation, and to select that which gives the largest mean annual net income. Adopting the data given on page 513, which represent the growth of a Scotch pine forest on land of middling quality, the mean annual net income under a rotation of 80 and 100 years would be as follows:—

$$\frac{2225 + 4 + 36 + 67 + 86 + 91 - (60 + 3 \times 80)}{80} = 27{\cdot}61 \text{ shillings.}$$

$$\frac{3376 + 4 + 36 + 67 + 86 + 91 + 95 + 94 - (60 + 3 \times 100)}{100} = 34{\cdot}89 \text{ ,,}$$

Under this mode of calculation, which takes no account of interest, the mean annual net income increases with the length of rotation, and this increase continues until volume- and value-increment become so much reduced that they will no longer cover the increased outlay. This result, however, does not agree with what has previously been explained. If, as ought to be done, interest is taken into account, a rotation of 80 years is that which, in the case here assumed, yields the highest net rental, and is hence financially the most profitable.

The rotation to be adopted is, it may readily be imagined, a fertile subject of controversy, which often gives rise to animated discussions among foresters in Germany. The author is in favour of what is commonly called the financial rotation, under which the forest capital (soil and growing stock) yields the highest interest, and under which, as explained above, the soil expectation value and net soil rental culminate. But Dr. Schlich justly observes that purely financial interests must in many cases be modified by considerations of a different character.

How the annual yield, that is the timber which may be cut annually or within certain periods, is determined in the case of coppice woods, has already been indicated. In the case of high forest, three different systems are generally followed. The first of these the author designates as the allotment of woods to the different periods of a rotation. A rotation of 80 years is divided into four periods of 20 years each. It will serve to make matters clear, if we assume the existence of a normal forest with an even distribution of age classes. To the first period would be assigned in such a forest all woods between 61 and 80 years, to the second those between 41 and 60 years, and so on, so that the fourth class would comprise the youngest woods under 20 years. Such a regular forest, however, does not exist, and what in reality is done, is to assign the oldest woods to the first period, and to distribute the others according to their age, as well as can be done. A number of compartments, stocked with old timber, are thus assigned to the first period, and care is taken to allot to each period approximately equal areas, which, if there are great differences in the quality of the locality, are reduced to a common standard. The woods placed in the first period are then measured, their volume calculated, and the increment for half the number of years in the period is added. The total volume divided by 20 gives the mean annual yield during the first period. The cuttings in the woods assigned to each period are arranged so as to suit sylvicultural requirements and economic considerations. The allotment of compartments to periods can obviously be made by volume instead of by area. In that case old woods are measured, and the proper increment added. For younger woods the volume, which will stand on the ground at the time of cutting, is calculated from yield tables. Equal volumes are assigned to each period, the oldest woods being allotted to the first, and the youngest to the last period. The compartments allotted to one period, whether by volume or by area, will not necessarily be contiguous; they will often be scattered over the whole forest. Whether the allotment to periods is regulated by area or by volume, a framework must be constructed, showing during which period each wood is to be cut. Hence this system is commonly known as the framework system. However irregular the forest may have been; at the end of the rotation its condition will approximate to the normal state. Thus the system introduces order, and is yet elastic, leaving sufficient latitude in the location of cuttings during each period.

The second system regulates the yield according to increment and growing stock. The legitimate yield of a forest during a given period in the first instance depends upon the quantity of timber produced during that period. During one year more should not, as a rule, be cut than the quantity represented by the sum total of the annual increment laid on in all portions of the forest. In a normal forest, with a regular succession of age classes, the legitimate annual yield is equal to the annual increment. In a forest, however, which, though well stocked, only contains the younger age classes, the produce of which is not marketable, no yield is possible, though the annual increment may be considerable. Again, in a forest where the older age classes preponderate, it is not only permissible, but it is in most cases necessary, to cut considerably more than the total annual increment. This principle has long been recognised, and as early as 1788 the management of the Austrian State forests was based upon it. When the older age classes preponderate, it is proper to fix a period, during which the surplus old growing stock shall be removed. If this period is called a, and I the actual annual increment, then the legitimate annual yield of the forest is

$$= \text{I} + \frac{\text{actual growing stock} - \text{normal growing stock}}{a}$$

This, which is known as the Austrian assessment formula, is still used in many public and private forests of Austria and Germany. Space forbids further discussion of this and similar methods. Suffice it to say that under this system no framework is needed, and that on this principle it is best to determine the yield for a short period only. Hence in those forests, where this system has been adopted, the yield is generally determined for ten years, and at the expiration of this time a new working plan is made.

The third system, which is in force in the State forests of Saxony, was originated by Cotta in 1811, and has been

brought to its present state of perfection by Judeich, for many years until his death in 1894, Director of the Tharand Forest School, one of the ablest foresters of Germany. Its leading idea is to treat each wood, or each compartment, or each group of compartments, on its merits, the management of the whole forest representing a summing-up of the treatment laid down for each wood. It has already been stated that a large portion of the State forests in the kingdom of Saxony are nearly pure spruce forests, managed on a very simple system by clear cutting and planting, and that most of them are worked on a rotation of 80 years. At first sight elaborate working plans might seem to be superfluous under these circumstances; it might be thought sufficient if a suitable area of the oldest woods were cleared and planted annually. However, had the forests been worked in this manner, without safeguards against storms and insects, their condition would not be what it actually is, nor would the financial results be so satisfactory. Pure spruce woods are apt to be blown down. Spruce plantations are apt to be destroyed by the pine weevil, and it was to a great extent the necessity for guarding against damages from these causes which led to the development of the present system in Saxony. On the spurs and in the valleys of the Erzgebirge and the other mountainous regions of Saxony, where most of the State forests are, the direction of the prevailing winds, though generally westerly, is greatly modified by the configuration of the ground. Accordingly the cutting series, in which all clearances proceed against the wind, must be most skilfully arranged, so as to guard against damage. Again, in order to guard against the ravages of insects, the principle of breaks in the successive clearances has been consistently carried out. When in one spot a cutting has been made, the adjoining area is not cleared until the young wood on the first area has become completely established. The result consists in numerous cutting series, separated by severance cuttings, and numerous clearances of limited extent. An essential feature in this, as in the second system, is that the yield is determined only for a period of 10 years. The woods proposed for cutting during that period are carefully examined. According to Judeich's plan, the question whether a wood should be cleared is determined by purely financial considerations. Dr Schlich, however, very properly urges that other considerations also should have due weight. Obviously a regulator is necessary, to prevent too large an area being assigned to one period. This regulator is obtained in a very simple manner. The total area is divided by the rotation. For a forest of 2400 acres, worked under a rotation of 80 years, 300 acres would be the area cleared during a period of 10 years.

The system here sketched is simple and effective, but, like all systems, the results depend upon the manner in which it is worked. The young woods must be complete and vigorous, and though the outlay in forming them, is multiplied seven-fold in 80 years under the operation of compound interest, even at the low rate of $2\frac{1}{2}$ per cent., undue economy in this first operation, and in the subsequent tending of the woods, would result in waste and diminished net revenue from these magnificent estates.

Thus far the management of forests has been discussed, as if timber were the only legitimate forest produce. This, however, by no means is the case. Large plantations have been made in Assam by the Forest Department, ever since 1870, of *Ficus elastica* for the production of india-rubber. Myrobalans, the fruit chiefly of *Terminalia chebula*, is an important article of forest produce in Western and Central India. The Scotch pine forests which surround the old town of Nürnberg, are important, less on account of the timber which they produce, than because the annual fall of needles furnishes litter to the peasants in the vicinity, who chiefly depend upon the growth of vegetables, and who use the dry needles as a substitute for the straw which they do not produce. In the drier regions of India, a commencement was made in 1874 to protect woodlands for the specific purpose of furnishing cattle fodder in times of drought. Had these attempts been carried on with sufficient vigour and perseverance, they might have contributed largely to mitigate the sufferings of the agricultural population during seasons of deficient rainfall, which in most parts of the Indian Empire occur from time to time.

Other articles of produce obviously demand other systems of management. With these, however, forest proprietors in the United Kingdom at present have no concern. Their interest is to produce timber of the best description, and to sell sufficient quantities to attract purchasers at regular intervals. A beginning can only be made by actual experience. Should any proprietor have the courage and foresight to ask the author of the manual here reviewed, or any other really competent and experienced forester, to take in hand his forest estates, and to organise their management on a well-considered plan, the result would certainly induce others to follow suit. In a matter of this kind, example is better than teaching, and the sooner a commencement is made, the better for the landed interest of Great Britain. Patience, however, and plodding perseverance, are indispensable conditions of success in forestry. Timber takes many years to attain marketable size, its growth in volume and value is slow, and the money returns are moderate. These are the chief reasons why systematic forestry is not yet respected in Great Britain. In this, as in other matters, the pressing needs of the moment stand in the way of undertakings which would, slowly but surely, advance the future welfare of the country.

THE PROTECTION OF FORESTS.

We now pass to the consideration of that branch of forestry which deals with injurious external influences, and with the measures that may be adopted to guard against them. These matters form the subject of Mr. Fisher's volume. In the introduction a brief account is given of the earliest attempts at forest protection, sacred groves, and game preserves. Sacred groves are found in many parts of India. In the moister regions, where forests are abundant, we find them, as Mr. Fisher correctly observes, in the hills south of the Brahmaputra river, but also in other districts; for instance, upon the Javadies and other hill ranges of South India. In the regions with a dry climate, as in Rajputana, the sacred groves of *Anogeissus pendula* are an ornament of the country, and have often proved a boon to the people by providing cattle fodder in seasons of drought. Old game preserves have in many instances been transformed into useful forests. The forests of Babul, *Acacia arabica*, on both sides of the Indus River, were originally formed and maintained as the game preserves of the Ameers of Sind, and are now of considerable importance in that dry and otherwise forestless country.

Part i. is devoted to the protection of forests against man. The destruction of forests through other agencies is insignificant, compared to that accomplished by the improvident cupidity and careless ignorance of man. These tendencies of mankind the entire manual is intended to counteract, in so far as it teaches how forests should be maintained and managed. The present volume only deals with special matters in this respect, the protection of forests against encroachment, damage, misappropriation, irregular and excessive exercise of rights of user.

Part ii. deals with protection against animals. Here the chapters relating to insects are the most important. The damage done to forests by caterpillars and beetles must be seen in order to be believed. The Nun Moth (*Liparis monacha*) has for several centuries been known as one of the most formidable enemies of spruce forests in Germany, Austria, and Russia. It is also very

injurious to the Scotch pine, and likewise feeds upon the leaves of the beech and other broad-leaved trees. From 1888 to 1891 this caterpillar appeared in such enormous numbers in the spruce woods of South Germany, particularly of Bavaria, that over large areas the trees became entirely denuded of their leaves, and were killed. In the Ebersberg Park, a densely stocked forest, spruce with a small proportion of beech and Scotch pine, forming a compact area of 16,510 acres, 4700 acres were completely bare, while on 7400 acres the trees were severely damaged. The timber that had to be cut on this area, in consequence, amounted to 53,000,000 cubic feet, more than half the normal annual yield of the State forests in the kingdom of Bavaria. Timber-cutters were brought from all parts of the country, and lodged in temporary barracks built in the forest. A railway seven miles long was constructed into the heart of the devastated area; tramways were laid upon the rides separating the compartments, and portable lines were used to bring out the logs. At the same time the Nun had devastated other extensive areas in Bavaria and the adjoining districts of Württemberg, necessitating the cutting of large quantities of timber. The news of these events created great uneasiness among timber traders, and a disastrous fall in timber prices was anticipated. This, however, was to a great extent guarded against by the prompt and carefully-planned measures taken by the Bavarian Government. The annual cuttings in the Bavarian State forests were at once considerably reduced, and the action thus taken was aided by the circumstance, that the timber of the Ebersberg Park has a very good name, and justly so, for the stems are well-shaped, clean, without knots, and the wood is even-grained. Most of the large timber was sent across the Alps by the Brenner line, and found a ready market in Italy. The smaller pieces were sold to paper factories to be converted into wood pulp, and what was only fit for fuel was collected at the great depôt that supplies the town of Munich with firewood. The cleared areas have since been planted up, and except that the working plan of the forest was completely upset, no permanent damage was done by the calamity.

If the timber of Conifers killed by caterpillars is not cut at once, it is apt to be much injured by bark beetles. In the present instance this was avoided; but formerly, with the means of communications less developed, and the plan of action less prompt and less comprehensive, the ravages of *Tomicus typographus* and other bark beetles have greatly intensified the mischief. In North Germany and in Russia the principal devastations by the Nun, and by the bark beetles in its wake, have been recorded in 1688 (Altmark), 1794 to 1797 (Southern Thuringia), 1837 to 1840 (the greater part of Germany, from the North German Plain to the lake of Constance), 1845 to 1867 (Western Russia and Eastern Prussia, extending over forest areas aggregating 32,000 English square miles).

The moth lays about 150 eggs, and, as is the case with other species (for instance, *Orgyia antiqua*), the male and female insects of one brood attain the perfect stage on different dates, necessitating the inter-breeding of different broods, and thus insuring a vigorous development of the pest. A succession of warm dry springs, with weather otherwise favourable to the life of the insect, brings about the rapid multiplication of the Nun, and, unfortunately, the protective measures are difficult, and their success uncertain.

Fortunately, the Nun has formidable enemies. A number of birds eat the eggs—up to 200,000 eggs have been found on one tree; but only the starling eats the hairy caterpillars on a large scale. Of insects, parasitic *Diptera* (*Tachinidæ*) are exceedingly useful in destroying the caterpillar wholesale. The most powerful ally of the forester, however, has in most cases been an epidemic disease, which breaks out among the caterpillars when the multiplication has attained its climax. They congregate in large masses at the tops of trees and branches, where they die without making any attempt at feeding. In the diseased caterpillars several species of bacteria have been found in large numbers; attempts have also been made to inoculate healthy caterpillars with these bacteria; the success, however, has not been sufficient for practical purposes.

Equally mischievous, not, however, in spruce woods, but in those of the Scotch pine, is the Pine Moth (*Gastropacha Pini*), a species, Mr. Fisher states, not found in Great Britain. Formerly the Pine Moth was dreaded as the greatest enemy of the extensive pine forests of Northern and Middle Germany. Fortunately, however, when its life-history became better known, a simple and most effective remedy was devised. The eggs are laid early in August; the caterpillars, which come out about the end of that month, proceed at once to feed on the needles; but, being small, the damage done at this season is not considerable. When night frosts commence, they descend from the trees, and spend the winter months ensconced in moss or dry needles near the foot of the stem. In spring, aroused by the warmth, they ascend the trees and eat them bare in no time. The average consumption by one caterpillar is estimated at 1000 needles. What is done by way of protection against this pest, is to prevent their ascending the trees in spring, and this is effected by putting broad bands of tar, grease and glue, mixed, round the stems, the outer rough bark having first been scraped off to present a smooth surface. These sticky bands the caterpillar cannot get over, and in this manner nearly the whole of the pine forests in the plains and broader valleys of Germany are now protected against the ravages of this insect. The pine woods on the hills, having generally a mixture of other trees, are safe from the attacks of the Pine Moth.

The Scotch pine has many enemies besides the Pine Moth. During the summer of 1895 the Pine Noctua (*Noctua piniperda*) and the Pine Looper Moth (*Geometra piniaria*) have appeared in immense numbers, the former between Darmstadt and the Main River, and the latter in the forests near Nuremberg, as well as in the Rhine Valley.

Among insects which attack young plants, the Pine Weevil (*Hylobius abietis*) is one of the most mischievous. The larva does not do much damage, but the beetle is found in large numbers in plantations of spruce and Scotch pine up to six years of age, killing the plants by gnawing the bark all round the stem, down to the root. It lays its eggs on stumps and roots, and the best protection is to give him as little opportunity as possible for breeding in the vicinity of young plantations. Small felling areas and intermittent fellings ought to be the rule; when a clearance has been made, the adjoining area should not be cut until after the lapse of three to five years.

Of the Cockchafer (*Melolontha vulgaris*) the beetle does some damage by eating the foliage of broad-leaved trees, particularly of the oak; but the chief mischief is done by the larva, which eats the roots of plants. A fungus (*Botrytis tenella*) some years ago in France was found to infest the larvæ, and at one time it was hoped that it might be possible, by inoculating larvæ with the spores, to spread the infection, and thus to destroy a large portion of the brood. Experiments have been made with great care in France, in Switzerland, and at Berlin, but hitherto without practical success.

Part iii. discusses protection against plants, forest weeds, climbers, parasitic and epiphytic phanerogams and fungi. In tropical and sub-tropical forests huge woody climbers play an important part, and are often very mischievous. They bend and twist the trees on which they have found their support, and finally, by their

dense luxuriant foliage, smother them. Several species of epiphytic ficus enclose the stem of teak or other useful trees by a network of aërial roots. The extirpation of climbers and epiphytes forms an important part of a forester's duty in India. Our North Europe climbers, the honeysuckle and *Clematis Vitalba*, are innocent representatives of those gigantic enemies of the forester in warmer countries.

Green parasites, such as *Viscum* and *Loranthus*, probably in a manner contribute their share towards the nourishment of the tree upon which they have established themselves, and some botanists have even gone so far in their appreciation of this symbiotic arrangement, as to claim for the mistletoe the gratitude of the apple-tree, upon which it lives. Be that as it may, in the Southern Schwarzwald, chiefly at lower elevations, *Viscum album* to such an extent infests the Silver Fir that many trees are killed, and that much of the timber is rendered useless by the haustoria of the parasite. And on the Nilgiris of South India several species of *Loranthus* have attacked the plantations made on those hills of the Australian *Acacia melanoxylon*, killing a large number of trees.

The damage done to trees by fungi has of late years justly attracted much attention. *Phytophthora omnivora*, de Bary, closely allied to the potato pest ((*P. infestans*) attacks the seedlings of the beech and other broad-leaved trees, and destroys them wholesale in May and June, especially if protracted wet weather sets in.

Æcidium elatinum, Link, is the fungus which infests the Silver Fir, manifesting itself in two different ways—by an abnormal hypertrophy of the branches, known as witches' brooms, and by canker or diseased swellings of the stem. The trees attacked with canker are worthless for timber, and the damage is very considerable. Nothing, however, can be done in the matter, save to destroy the branches bearing witches' brooms, and to cut out all trees attacked by canker. Fortunately, the system of management which suits the Silver Fir best, selection fellings, or gradual cuttings under shelter woods, permits the removal of canker trees.

The dreaded Larch disease is chiefly caused by a fungus (*Peziza Willkommii*, R. Hartig). Wounds made by the Larch Miner Moth, *Tinea* (*Coleophora*) *Laricella*, facilitate the entry of the spores into the tissue.

Broadly speaking, the most effective protection against the ravages of insects and fungi is a correct system of management. One important result, arrived at by long experience, in this respect, is that all other circumstances being the same, mixed woods are less exposed to such ravages than pure woods, consisting of one species only. Short-lived plants, such as our field crops, are exposed likewise to damage by insects or fungi; but, in the case of trees and shrubs, the damage is intensified, because they furnish food and other circumstances favourable for the multiplication of the pest, not during one season only, but continuously. This has been our experience hitherto, in the case of forests, as well as in the case of plantations of coffee, tea, cinchona, or other woody plants. The vineyards of Europe are a case in point. *Oidium Tuckeri*, Berk., commenced its ravages in South Europe in 1851, nearly destroyed the vineyards of Madeira, and probably was the fungus which, in 1856, put an end to the cultivation of the grape in the valley of Kunawar in the North West Himalaya. During the last ten years, two pests, a fungus and an insect, both introduced from North America, have done enormous damage—*Peronospora viticola*, de Bary, and the dreaded *Phylloxera vastatrix*, Planch. The coffee plantations of Ceylon have been annihilated between 1869 and 1880 by that terrible fungus *Hemileia vastatrix*, Berk. In Java, where this fungus has also made its appearance, without, however, doing much damage, other trees are invariably planted with the coffee, and this to a certain extent is also done in the coffee plantations of Coorg and the Wynād. In the extensive and magnificent tea plantations, which now cover the Assam valley, it formerly was the custom to preserve belts of the original forest on broken ground and along ravines, and the experience of foresters in Europe points to this plan as an important safeguard against the spread of fungus and insect pests. Among foresters in Germany and in other countries on the continent of Europe, the conviction has now generally gained ground, that every effort must be made to maintain mixed woods, consisting of several species, where they exist, and in pure forests to introduce a mixture of other species, wherever such is practicable. The object is to make the conditions for the multiplication and spread of insects and fungi less favourable than they are in pure forests, consisting of one species only.

The forester, unfortunately, has to contend with other enemies besides man, animals, climbing plants and fungi. The heat of the sun, drought, frost, snow and ice, storms and fires, smoke and acid fumes of factories and furnaces are destructive to an extraordinary degree, and often entirely upset his plans of operations. And in addition to all this, some species are subject to endemic widely-spread disease, such as the needle-shedding of young Scotch Pine plants, the cause of which has not yet been ascertained. All these matters are dealt with in the concluding parts of Mr. Fisher's book.

The recollection of the storms which blew down enormous masses of timber in Scotland in 1893 and 1894, ought to invest this portion of the book with special interest. Here again a correct system of management affords the best protection. Cutting series of moderate extent, adapted to the configuration of the ground and to the locally prevailing wind direction, severance cuttings timely made—these are the principal measures by which the extensive pure spruce forests of Saxony and Thuringia have, it is true, not been absolutely protected against storms, but protected so far, as such is possible in pure forests consisting of a shallow-rooted species that is easily blown down.

Protection against fire is not a matter of great practical importance in the moist climate of Great Britain. Mr. Fisher has, nevertheless, very properly treated it somewhat fully, and has also alluded to the work of fire protection in India. The peculiar feature of the climate in most provinces of India is the long dry season, at the end of which grass, leaves, herbs, are as dry as tinder. The natural results are the annual jungle fires of the hot season, an institution as old as the civilisation of the country. To the annual fires it is due that fully stocked and healthy forests were the exception, when the first attempts at regular management were made, and that the main portion of the so-called forests were groups of trees, separated by vast areas of scrub and grass land. Moreover, the majority of the older trees were unsound, hollow and crippled, the soil was hard and impoverished, and it was clear that protection against fire was the most important task to be accomplished, if real improvement of the forests was to be effected. The attempt, however, to put an end to this time-hallowed institution met with powerful opposition on all sides. Colonel Pearson, the Conservator of Forests in the Central Provinces, was the first to succeed in keeping out fires from the Bori forest in the Satpura hills. This was in 1865, and a few years later the effect of continued protection in that district was marvellous. This and other forests which have thus been really protected, are now dense compact masses of healthy trees and bamboos, which can with advantage be subjected to regular management. The total area of fire-protected forests in the British Indian Empire in 1893 amounted to 27,438 square miles, which is nearly three times the area of State forests in the kingdom of Prussia.

Proprietors of forest lands in Great Britain and in the

United States of North America will do well to bear in mind the success of fire conservancy in India. Systematic forest management is a difficult undertaking, which has many enemies. Nevertheless success is possible, and if these forestry manuals facilitate the attainment of success in this business, their authors will have reason to be well satisfied with their work.

DIETRICH BRANDIS.

THE DEVELOPMENT OF BUTTERFLIES UNDER ARTIFICIAL CONDITIONS.

The effects which cold and heat, applied to the pupa, produce in the colours and patterns of the imaginal wings, have been studied for many years and by many naturalists. Weismann in 1875 published an account of his own experiments, and those conducted by others, in an essay which was published in this country in 1882 among the "Studies in the Theory of Descent," translated and edited by Meldola.

The experiments described by Weismann have been repeated and greatly extended by Merrifield (*Trans.* Ent. Soc. Lond., 1888, 1889, 1891, 1892, 1893, 1894), while Dixey has published interesting observations on the phylogenetic significance of some of the results obtained (*Ibid.*, 1893, 1894).

While these careful and successful experiments were being conducted in this country, Standfuss of Zurich has been independently engaged on the same research, employing in many cases the very species which had been used by Merrifield. Standfuss's paper, appearing in 1894, has been translated by Dixey, and, after revision by the author, has been published, with an introductory note by Merrifield, in the pages of *The Entomologist* for March, April, and May 1895. The editors of this journal are to be congratulated on the effort they have made to lay before their readers some of the interesting results of entomological research conducted by continental naturalists. We may hope that the attempt which has been so successfully made, will be frequently repeated.

(1) *The Egg.*—The eggs of four species of moth (*Arctia fasciata*, *Dasychira abietis*, *Lasiocampa pruni*, and *L. pini*) were exposed to a high temperature, 34° C. (93° F.), as they were being laid, and subsequently up to the time of hatching. The larvæ hatched in two-thirds or less of the normal time, and although the temperature remained normal, 25° C. (77° F.), throughout the subsequent stages, 71 per cent. of *fasciata*, 90 of *abietis*, 100 of *pruni*, and 81 of *pini* emerged as imagos in that year, the remainder hybernating as larvæ; as against 23, 12, 64, and 28 per cent. respectively, when eggs from the same parents had been laid and kept at a temperature of 22° C. (72° F.) and at 25° C. during the subsequent stages. This persistence throughout the later stages of the hurrying-up of development, when the conditions which originally started it had ceased at the beginning of larval life, is very remarkable, and it is unfortunate that the author should have contented himself with giving his results in percentages instead of the actual numbers obtained. This criticism applies to nearly all the results recorded in the paper.

There was no evidence that the imagos were otherwise influenced by the condition of the ova.

(2) *The Larva.*—Experiments with an increased temperature generally shortened the period of larval development and reduced the size of the imago. From these experiments the author infers that the great difference in size between certain closely allied species (*e.g.* *Boarmia consortaria* as compared with the much larger *B. roboraria*) has been produced by the larvæ reacting in a different manner under changes of temperature, so that some acquired long and the others short larval periods. It would appear that the evidence in favour of this conclusion has not been sufficiently sifted, and that certain obvious difficulties raised by this interpretation have been overlooked.

Certain changes in form, colour, and marking are also described as following the temperature conditions of the larvæ. In these cases, however, the author does not appear to be giving the results of his own experiments, but reasoning from the differences observed in the several broods of many species appearing at different seasons, and especially contrasting the forms produced from hybernated larvæ with those produced without hybernation. In these cases it is the duty of the naturalist to determine by means of artificial experiments whether the observed changes are entirely due to conditions of temperature, and whether the larval stage alone is of importance.

Many experiments were made with foods, polyphagous larvæ being fed on poisonous or acrid plants, on such abnormal diet as raw meat, or on plants which had absorbed solutions of various substances. The perfect insects "often enough showed a failure in size or general colouring, but in no case any noteworthy variation in tint or pattern."

The effects of light transmitted through glass of different colours were negative, although the larvæ were exposed to these conditions "from the time when they were quite small."

(3) *The Pupa.*—By far the most complete results were obtained by subjecting the pupa to various degrees of temperature.

The effects obtained with *Papilio machaon* and *Vanessa antiopa* are of especial interest, inasmuch as Merrifield's material had been inadequate and his results, as regards these species, negative.

Seventeen pupæ of *P. machaon*, kept at a temperature of 37° C. (98°–99° F.) from the time when the cuticle hardened at the beginning of pupation, produced in seven to ten days fifteen insects, which were much lighter in colour than usual, owing to the development of a yellow powdering which obscured many of the dark markings on the upper and under sides of the wings, and the body. Changes in form are also described, including a marked lengthening of the "tail" of the hind wing. "Some of these specimens . . . bear a perfect resemblance to those that fly in August in the neighbourhood of Antioch and Jerusalem." The pupæ subjected to cold (for twenty-eight days) produced only two imagos, and these resembled the Swiss and German forms emerging from hybernated pupæ.

The pupæ of *Vanessa antiopa*, after being exposed to heat (37° C. or 98°–99° F.) for forty-eight hours, produced, ten days later, butterflies in which the marginal blue appeared to be reduced, and the yellow border broadened, but in neither case to a greater extent than in nature. Among these individuals, however, 2 per cent. presented a very remarkable variation, which Standfuss has named var. *daubi*. This well-marked form is constantly produced when the pupæ were exposed to heat (as above) for sixty hours, and then kept at a temperature of 24° C. (75° F.). Such pupæ produced the var. *daubi* in twelve days. The upper surface of both wings is greatly darkened, becoming almost black, the blue spots are much reduced and have a violet tinge, but the most remarkable change occurs in the yellow border, which is extremely darkened, so as to leave, in extreme cases, only a small remnant of yellow scales. The under side is as much darkened as the upper; and certain changes in the form of the wings are also described.

Cold produced very different effects according to the time of exposure. The most interesting results, and those which most strongly suggest the appearance of allied species (*V. urticæ*, *V. polychloros*), followed the shortest exposure of twenty-nine to thirty-four days in the refrigerator. In these cases the brown ground colour became lighter, and the blue spots (much enlarged on the

fore wing) acquired dark borders. At the same time traces of dark spots, like those of the allied species, appeared in certain individuals, while the under side, especially of the hind wing, underwent changes which are also described in *V. io*, gaining a pattern in brown scales which recalled that of *V. polychloros*, &c. A longer period (thirty-nine days) produced far less interesting results, the blue being increased, the yellow border diminished, and the ground colour darkened. Forty-four days in the refrigerator produced more marked effects in the same direction, the blue spots of the hind wing being so increased that they project into the yellow border. The ground colour of both upper and under sides is much darkened. This beautiful variety is called by the author var. *roederi*.

As regards other species of butterflies, Standfuss's results afford valuable confirmation of those obtained by Merrifield. Thus heat (37° C.) produced light-coloured imagines of *Grapta C-album* with less sharply-defined markings and less deeply indented wing margins; while cold produced opposite effects, the dark colours of the under sides of the wings being often "mingled with moss-green tints."

In *Vanessa polychloros*, heat (37° C.) reduced the marginal blue spots and the dark wing-border, and brightened the colour of the upper sides of the wings, cold producing the opposite results.

In *V. urticae*, more extreme effects in the same direction were witnessed, heat causing an approach towards the var. *ichnusa*, and to a certain extent towards *V. io*; while cold produced butterflies which recalled the North American *V. milberti*. It was noteworthy that pupae kept on ice for forty-two days (emerging thirteen to fourteen days afterwards), produced less deviation from the normal than those which had been exposed for only thirty-two days, and emerged nine to ten days afterwards. In neither case is there any record of the numbers of individuals made use of.

In *V. io*, heat produced little result, while cold (thirty-five days in refrigerator) caused most interesting changes in the direction of *V. urticae* and *V. polychloros*. A longer period of cold (forty-two days) still further intensified these changes, which affected the under as well as the upper sides of the wings, the well-known uniform darkness of *V. io* giving place in the most extreme examples to a sharply-defined pattern in brown scales, far more suggestive of the above-mentioned species of *Vanessa*.

In *Vanessa atalanta*, heat greatly reduced the blue in margin of the fore wing, widened the red band, and reduced the apical white spots; thus approximating towards *V. callirrhöe*. Cold (thirty-one days) conversely increased the large white spot, reduced the red band by the encroachment of dark shades, and increased the blue. A longer period of cold (forty-two days) produced ten almost normal insects and a single extreme form. It would therefore appear that less effects were, on the whole, produced by the longer period, although the materials for a valid comparison are absent, inasmuch as the author only informs us that there was "much individual variation" in the results of the shorter period.

In *Vanessa cardui* a higher temperature (40° C. = 104° F.) was made use of for two periods of six hours, alternating with one of twelve hours at the normal temperature (about 22° C. = 72° F.). Only two pupae out of forty-two failed to emerge, although twelve produced crippled butterflies. Four specimens were of the var. *elymi*, the remainder normal. In another experiment with 36° to 37° C. for sixty hours, a remarkably pale form was produced; while in other cases the red colour, often acquiring a brownish tinge, was increased in extent on both upper and under surface of the wings. Cold (twenty-three days), on the other hand, darkened both sides of the wings. A longer period of cold (twenty-eight days) produced, on the whole, rather more extreme effects.

In *Argynnis aglaia*, heat (four days at 36° C.) produced very little effect, the ground colour of the upper sides of the wings being lighter, the greyish-green shades of the under sides darker and more conspicuous than usual. After twenty-eight days of cold, only three uninjured insects emerged from twenty-one pupae; in these the ground colour was unaltered, the black spots at the base of the fore wing enlarged, while the greyish-green shades, described above, gained a brown tinge. After a longer period of cold (forty-two days), two insects emerged from twelve pupae, and these showed far more extreme effects in the darkening of both upper and under sides of the wings.

The pupae of *Dasychira abietis* were killed by heat 37° C., while cold (forty-two days) tended to darken the insects.

Some experiments were also made upon the effects of comparative dryness and moisture upon the pupae. Large numbers of pupae of *Saturnia pavonia* were kept very dry from June to the end of September, and were then exposed to moisture; a treatment which the author believes, from repeated experiments, causes about 1 per cent. of the moths to emerge in about ten to twenty days, instead of hybernating. In these moths the pattern was "not sharply outlined, but more or less washed out and confused."

Towards the end of the paper the author gives a brief and general account of the results obtained by subjecting the pupae to heat and cold. He summarises the various classes of effects as follows:

(1) "Seasonal forms" similar to those which are known to occur in nature (*V. C-album* and *P. machaon* to some extent).

(2) Local forms and races similar to those which occur constantly in certain localities (*V. urticae*, *cardui*, and to some extent *P. machaon* and *V. antiopa*).

(3) Entirely exceptional forms or "aberrations," also occurring from time to time in nature (*V. io*, *V. cardui*, *argynnis aglaia*).

(4) Phylogenetic forms, not now occurring on the earth, "but which may either have existed in past epochs, or may perhaps be destined to arise in the future" (*V. io*, *V. antiopa*, *V. atalanta*).

This portion of the paper, although of interest, is not equal to the experimental portion, and cannot be in any way compared with Dixey's careful consideration of the results of Merrifield's experiments.

It is to be hoped that Dr. Standfuss will continue his experiments on this most interesting subject. E. B. P.

A NEW SYNOPSIS ANIMALIUM—DAS TIERREICH.

FROM rough calculations lately made by the contributors to the *Zoological Record*, it would appear that some 360,000 species of animals have been described by naturalists up to the present date. To arrange all these species on a uniform system, and to add descriptions and other necessary particulars to each of them, would appear to be almost an herculean task. Yet it has been undertaken, we are told, by the German Zoological Society, which has entered into an agreement with Messrs. Friedländer and Son for the publication of such a work. Prof. F. E. Schultze, of Berlin, has been selected as general editor of "Das Tierreich," and will be assisted by numerous sub-editors in the different departments of zoology. Each of these sub-editors again will invite the assistance of specialists in the groups assigned to his charge, so that a very large number of naturalists will assist in this gigantic undertaking. It is proposed to issue the first parts of the work in 1897, and it is expected that at least twenty-five

years will elapse before the undertaking can be brought to a conclusion.

On looking down the list of contributors whose services have been already secured for "Das Tierreich," we see, as might have been expected, that they are mostly Germans. But a certain number of English and French naturalists, and some from America and Italy, have already given their adhesion to the plan, and have undertaken to furnish certain portions.

The language employed will be, as a rule, German, but contributions in English, French, and Latin will also be received.

In order to show the general style of the proposed work, Messrs. Friedländer and Son send out along with the prospectus a synopsis of the small group of *Heliozoa*, prepared by Dr. Fritz Schaudinn, of Berlin. So far as we can judge from this portion of the work, the information which it is proposed to give will be exactly what is required for such a manual, and the whole work, if carried out upon this plan, will be of the greatest value to zoologists.

One little criticism we may venture to make on the proposal. The title, we think, is not a very well-chosen one. Bronn's well-known and important work ("Die Klassen und Ordnungen des Thierreichs") has already monopolised the selected name, although in Bronn's days the new mode of writing it had not been introduced. A good Latin title, such as "Synopsis" or "Index Animalium" would have been better, and would have given to the work a more cosmopolitan character. Indeed, we believe that it would have been much better to have used Latin throughout the work, as the common language of science. There are many working naturalists in France, Italy, America, and England who do not understand German. But every one who has been to school acquired sufficient knowledge of Latin to understand a Latin diagnosis. And the proposed work will consist mainly of diagnoses.

NOTES.

THE first of the two annual conversaziones of the Royal Society will take place on Wednesday, May 6. This is the conversazione to which gentlemen only are invited.

MR. W. C. McDONALD has just given the McGill University, Montreal, further reason to be grateful for his unbounded generosity. We understand that he has offered to build and equip a building for chemistry and mining on the same scale as the engineering and physics buildings, which the University owe to his munificence, involving a cost of about £52,000. In addition to this, he has decided to found a chair of Mining Engineering and a chair of Architecture, and has added the sum of £31,000 to the endowment of the University. The completeness and liberality with which the physics and engineering departments of the McDonald buildings are equipped may be judged from an article which appeared in these columns in 1894 (vol. l. p. 558). We cherish the hope that Mr. McDonald's generous benefactions will create a spirit of emulation among those who are able to advance scientific education and research in this country by providing the necessary means.

THE well-known American naturalist, Mr. D. G. Elliot, and party left London for Somaliland on the 27th ultimo. The object of Mr. Elliot's expedition is to obtain a series of antelopes and other larger African mammals for the Field Columbian Museum of Chicago. Mr. Elliot had originally intended to go to Mashonaland for this purpose, but the recent troubles in South Africa induced him to change his plans. He will land at Berbera, and proceed southwards over the high plateau to the Shebeyli River, where he expects to find giraffes and Grévy's zebras. Mr. Elliot will endeavour to return to the coast by the valley of the Juba River, in order to procure examples of the recently-described Hunter's antelope (*Damaliscus hunteri*). Mr. Elliot takes with him a taxidermist from Chicago, and has secured in London the services of Mr. Dodson, who accompanied Dr. Donaldson Smith during his recent adventurous expedition in Lake Rudolph.

THE Liverpool Marine Biological Station at Port Erin is now quite full. The naturalists who have gone there to work, for the Easter vacation, are Prof. G. Gilson (Louvain), Mr. Arnold Watson (Sheffield), Mr. E. T. Browne (University College, London), Prof. Weiss, Mr. Gamble, Mr. Burtt, and Mr. Mellor (from Owens College, Manchester), Mr. Kermode (Ramsey), Mr. Clubb (Liverpool Museum), Mr. C. E. Jones and Prof. Herdman (University College, Liverpool). Several students from University College, Liverpool, are expected later. The tides have been exceptionally low, the weather is good, and the Committee have arranged several dredging expeditions, one of which will be to the deep water between the Isle of Man and Ireland.

THE death is announced of Mr. George Holt, who endowed the chair of Physiology in University College, Liverpool, and contributed altogether about £25,000 to the resources of the College.

ONE of the New York medical colleges has already incorporated instruction in the use of X-rays in surgery as a part of its regular curriculum.

AMONGST the experiments on Röntgen X-rays made during the past month by Italian physicists, several contributions may be cited which either tend to confirm the results established by other workers, or to establish new results. Signor A. Roiti describes (*Atti R. Acad. Lincei*) a series of experiments now in progress bearing on the question as to where these rays emanate. The principal conclusions arrived at are: (1) That fluorescence does not necessarily accompany the emission of X-rays; (2) that the rays are only emitted when kathodic rays impinge on certain substances, notably glass, aluminium, mica, platinum, and porcelain. Signor Roiti establishes some interesting results relating to the leakage of electricity which takes place when X-rays fall on a charged body. When the body in question is placed in a vessel from which air is exhausted, this leakage effect is found to diminish rapidly after the pressure falls below a certain limit, showing that the leakage effect depends on the presence of molecules, by which electricity is conducted from the charged body to the containing vessel.

OUR American correspondent writes, under date March 27:—"Reports are received of the favourable action of the Senate Committee with reference to the proposed National University, preliminary appropriations being recommended for 1897 and 1898. This measure is one which has often heretofore been broached at Washington, and has been so often deferred as to seem to many a hopeless scheme. Present indications, however, point to some real progress, and encourage the hope that something will at last be accomplished.—Progress in science seems to pervade all departments of the Government. Another notable move is the introduction into the Post-office at Washington, of cancelling stamps which indicate every day the weather forecast, and of course the stamps are changed from day to day. This scheme will be put in operation within a few weeks.

"THE site selected for the new free public library of New York, which has recently been so amply endowed, including the Astor and Lenox libraries and the Tilden bequests, is that of the old reservoir on the corner of Fifth Avenue and West Forty-second Street. At a public hearing before the

Mayor of New York, on March 25, the choice was approved by him; and application will be made to the Legislature for permission to use this site, which will no doubt be granted, as the old reservoir is now disused.

"THE annual exhibitions of the New York Academy of Sciences are now the scientific event of the year. The third annual exhibition was held on March 26, at the American Museum of Natural History. As a matter of course, the display of radiographs and radiographic apparatus attracted the most attention, and the lecture of the evening was by Prof. Pupin on the X-rays. A large and interesting array of exhibits was made in other departments. As space forbids any systematic report, a few salient features include the following: The new elements, argon and helium, were shown by electrical illumination, and their spectra exhibited. The astronomical exhibit included fine photographs of star clusters, and spectra of stars, planets, &c. A photograph was shown of a meteor trail at Arequipa, Peru, September 6, 1895. Improved apparatus for investigations in astronomy, physics, and experimental psychology included many novelties. A series of pictures giving restoration of extinct mammals was pronounced by palæontologists the most complete and accurate ever made. The exhibits in geology, mineralogy, and botany were numerous and interesting. President John I. Stevenson made a brief address, appealing to citizens of New York to move in the matter of securing a permanent home for the Academy.

"MR. BRYAN LAWRENCE, who died at New York, March 10, left a large number of bequests to various Roman Catholic charities, including several educational institutions. The larger educational bequests are 5000 dols. each to the American College at Rome, Italy, the R.C. Seminary, Westchester County, N.Y., and the American University (R.C.) at Washington, D.C.—Brigadier-General Thomas L. Casey, retired, for many years chief of engineers of the United States Army, dropped dead in the new congressional library building at Washington, March 25. He was engaged in superintending the construction of the building. The Washington monument, 555 feet high, being the highest structure in America, was completed by him some years ago, after a long delay in the work previous to his connection with it. General Casey was a Fellow of the American Association for the Advancement of Science.

"A NOVEL series of experiments is in progress at Wesleyan University, Middletown, Connecticut, to determine the nutritive and caloric value of food, and many other questions relative to nutrition and other vital processes. For this purpose a calorimeter is employed, consisting of a copper-lined box, measuring inside $7 \times 4 \times 6\frac{1}{2}$ feet, thus giving 182 cubic feet of air, within which space a man is confined for several days at a time. It is fitted with glass windows of three thicknesses. Fifty litres of air per minute are pumped in. Food is passed in three times a day through an air-tight tube, and is carefully weighed, as are all the exudations and excretions, and the quantity of heat is measured. A telephone enables the subject to converse with the outer world. The experiments are conducted by Prof. Wm. O. Atwater, and the expense is shared by the Department of Agriculture of the United States, Wesleyan University, and the Storrs Experiment Station at New Bethel. A careful record is kept of every action of the subject—of his hours of sleep, minutes of exercise, respiration, appetite, &c. To this end there are two watchers and two assistants, a watcher, who is a professor in the university, and an assistant being constantly present."

AT the Royal Institution, on Tuesday next, April 14, Prof. James Sully will begin a course of three lectures on "Child-Study and Education"; on Thursday, April 16, Prof. Dewar will begin a course of three lectures on "Recent Chemical Progress"; and on Saturday, April 18, Prof. W. B. Richmond, R.A., will begin a course of three lectures on "The Vault of the Sixtine Chapel." The Friday evening meetings will be resumed on April 17, when Prof. G. Lippmann will deliver a discourse on "Colour Photography."

THE next course of Cantor Lectures at the Society of Arts will be delivered by Prof. Henry A. Miers, on Monday evenings, April 13 and 20, the subject being "Precious Stones." The points to be dealt with are: (1) The properties which make precious stones esteemed among minerals; (2) the properties by which precious stones are recognised; (3) the distinction of stones which may be confused, as garnet and ruby, jacynth and cinnamon-stone, zircon and lux sapphire, garnet and olivine, tourmaline and diopside, &c. The lecture will close with some remarks on artificial stones. Mr. James Swinburne will deliver a course of Cantor Lectures on "Applied Electro-Chemistry," on Monday evenings, April 27, May 4, 11, and 18. Among the papers arranged for the meetings of the Society after Easter are: April 22, "The Perfected Photochromoscope and its Colour Photographs," by Mr. F. E. Ives; April 29, "Fruit Drying or Evaporation," by Mr. E. W. Badger. Papers at subsequent meetings will be read by Captain Abney, on "Orthochromatic Photography"; by Mr. Hudson Maxim, on "High Explosives and Smokeless Powders"; and by Mr. E. W. Moir, on "Tunnelling by Compressed Air."

THE French Association for the Advancement of Science held its annual meeting at Tunis last week, about four hundred members being present. The office-bearers of the Association were received by the Bey on Wednesday, April 1; and the French resident, M. Millet, welcomed the Congress on the following day. The principal streets of Tunis were elaborately decorated in honour of the occasion, and, as hotel accommodation was limited, the Lycée Carnot was placed at the disposal of visitors. The Association met at Algiers fifteen years ago, so the recent meeting was the second one held on African soil. Next year's meeting will take place at St. Etienne.

ON Thursday, March 26, Prof. Guido Cora, of Turin, delivered a lecture on the "Gypsies" (*Gli zingari*), in the Aula Magna of the Collegio Romano in Rome, having been invited by the Società Palombella (founded for the higher education of women). The lecture was attended by the Queen of Italy, the Minister and the Under Secretary of State for Public Instruction. Prof. Guido Cora gave a short but complete history of the question, dealing also with many facts about the origin, manner and habits of the gypsies in every part of the world. He referred in high terms to many British scholars of the subject, and to the importance of the "Gypsy Lore Society" of Edinburgh.

THE twenty-seventh annual meeting of the Norfolk and Norwich Naturalists' Society was held in the Castle Museum on Monday, March 30, the President (Mr. H. D. Geldart) in the chair. Sir F. G. M. Boileau, Bart., was elected President for the coming session. In his annual address, Mr. Geldart discussed the subject of Arctic distribution of flowering plants, especially with reference to the influence of the glacial epoch upon the flora of the British Isles. He concluded his remarks by suggesting, as a simple and likely solution of the difficulties arising from the present distribution of Arctic and Alpine floras, that before the commencement of the glacial epoch, what is now commonly known as the "Scandinavian" flora, but which would be better called the "Arctic" flora, was distributed from land then existing in the neighbourhood of the Pole; that a part of this flora, being well established,

had held its own without migration even to the present time, and that the hypothesis of destruction and migration of plants from north to south and back again was unnecessary to account for the actual facts of distribution.

In connection with M. Ragonneau's reported explanation of the "mango trick" of Indian native conjurers, it may be interesting to compare his results with Moggridge's observations on the harvesting ants of the Riviera. According to M. Ragonneau, the Indians sow the seed under experiment in earth which has been taken from an ants' nest, and the formic acid present causes it to germinate with extraordinary rapidity, and "grow up into a tree" before the astounded spectator. The French observer states that he has reproduced this experiment in every detail by sowing seeds in earth previously watered with a dilute solution of formic acid. On the other hand, Moggridge found that in seeds stored in the granaries of the Mediterranean ants the process of germination was indefinitely delayed. That their vitality was not destroyed was proved by removing and planting them in fresh earth, when they grew immediately. That ants should be capable of exerting such opposite influences on the growth of seeds is remarkable.

An interesting investigation on the specific heat of solutions has been given by Herr G. Tammann (*Zeitschrift für Physikalische Chemie*). It is well known that weak solutions of certain electrolytes have a smaller capacity for heat than the water present in them possessed previously to the introduction of the salt, and the object of the investigation is to establish a connection between this phenomenon and the contraction of volume which accompanies the process of solution. This contraction has often been accounted for by the hypothesis of a certain internal molecular pressure. Herr Tammann calculates the specific heat of the water present in a number of solutions of this class on the supposition that their pressure is the *increased* pressure postulated by the above theory, and he also calculates the specific heat of the dissolved substance, that of the mixture being deduced by adding the thermal capacities of the two components. The theoretical values thus obtained are found to agree closely with the values experimentally found by observing the solutions themselves, and it is inferred that contraction is the sole cause of the diminution of specific heat arising from the presence of the dissolved matter.

As an addition to the information about Northern Norway, contained in Dr. Reusch's article in Nature of March 5, we give the following data as to cloudiness, communicated to Mr. Lawrence Rotch by Prof. H. Mohn, Director of the Norwegian Meteorological Institute, and sent by him to *Science*. Prof. Mohn writes: "For Sydvaranger, the nearest place to Vadsö at which meteorological observations have been made, the amount of cloud on a scale of 0 to 10, and the chance in percentages of its occurrence are as follows:—

August 8, 8 p.m. Amount of cloud.	Chance.	August 9, 8 a.m. Amount of cloud.	Chance.
10	45·5	10	45·5
8	13·7	9	9·1
7	4·6	8	4·6
5	4·5	7	9·1
3	9·1	6	4·5
2	4·5	4	4·6
0	18·2	3	4·5
		2	9·1
		0	9·1
	100·1		100·1

Sydvaranger lies on the south side of the Varangerfjord, and Elvenes is the name of the posting station. Vardö, lying on the north side, is not to be recommended, having too often fog or clouded sky. In the interior of Finmarken the sun is lower than at Varangerfjord." Although the astronomical conditions of low altitude of sun and short totality are not good, yet Mr. Rotch thinks the meteorological conditions just noted compare favourably with those of stations in Japan, where the eclipse occurs later in the day and totality lasts longer.

From materials collected by the Meteorological Office from merchant ships' logs since the year 1854, from data contained in the logs and Remark Books of the Royal Navy since 1830, and from other sources, the Meteorological Council have prepared monthly current charts for all oceans, which will certainly prove of much value to navigators. The Hydrographic Office of the Admiralty has undertaken to generalise the large amount of material which has been collected, and already the charts for the Indian Ocean have been published. These generalised sheets show the average direction and rate of the currents, and other details; much valuable information has hitherto been masked by the grouping of the data for longer periods. They show, for instance, that near the African coast there is no month between January and July in which the rate of the Agulhas current does not occasionally reach 100 miles in 24 hours, and also that it follows very different routes after reaching the latitude of the Cape. The currents of the Bay of Bengal are shown to be subject to very abrupt changes with the change of the monsoon, but do not follow the precise direction that might be expected. In January there is a well-marked southerly drift near the coast, while in February the current assumes an entire change of direction, and sets to the northward. Similarly, important changes are shown to exist in the current round the southern part of Ceylon.

An ingenious and novel method, which it is hoped may prove of service in distinguishing genuine cholera-vibrios from their numerous rivals, has been recently introduced by Prof. Pfeiffer and Dr. Vagedes. Taking advantage of the now recognised fact, that the serum derived from cholera-immunised animals contains anti-cholera substances, Dr. Pfeiffer has traced the effect produced outside the body from cholera-vibrios when brought into intimate contact with such serum in artificial cultures. For this purpose broth, to which highly active cholera-serum was added, was inoculated with cholera-vibrios, and the effect watched under the microscope in hanging-drop cultures. The vibrios, usually so active, were almost immediately deprived of their powers of movement, and after twenty minutes' exposure to a higher temperature in the incubator, all traces of motility had vanished, although no morphological difference could be discovered in their appearance. When, however, such drop cultures were allowed to remain for twenty-four hours in the incubator, the vibrios were found to have almost completely regained their old activity, indicating that the original inimical effect produced by the serum had to a great extent been overcome. Dr. Pfeiffer states that this remarkable influence of the cholera-serum was only apparent with true cholera-vibrios, all the other numerous descriptions of allied vibrios which were examined being totally unaffected. Further extensive trials must be made before passing a final opinion upon this new method of cholera diagnosis, and Dr. Pfeiffer has expressed his willingness to assist all such investigations by supplying cholera-serum of the requisite degree of strength, to those who desire to carry out similar experiments.

A short paper by Mr. H. W. Seton-Karr, on his discovery of evidences of the palæolithic stone age in Somaliland, appears in the latest number of the *Journal* of the Anthropological Institute (vol. xxv. No. 3, 1896). His observations show that stone implements in Somaliland are found scattered all over the country, but probably mostly below the present surface, within a district included roughly between the Red Sea and lat. 9° 30′ N., and between E. long. 44° and 45°. Dr. Gregory made a collection of obsidian implements in Masai-land, but these were all neolithic; and he points out that, as no palæolithic implements

have been recorded from Tropical Africa previous to those described by Mr. Seton-Karr, if the identification of some of the specimens as palæolithic is verified, the discovery is a very important one.

IN nearly every county of Central and Northern Indiana there occurs a kind of black soil, often spoken of as "bogus land." It is also sometimes called "alkali," but not correctly, for the land has none of the essential characteristics of alkali soil. The improvement of these hitherto unproductive black soils is the subject of a *Bulletin*, by Mr. H. A. Huston, published by the Agricultural Experiment Station of Purdue University, Lafayette, Indiana. It is asserted that thousands of acres of such soil are susceptible of amelioration to such an extent as to be made the most productive maize lands in the State. The use of straw or kainit has proved very profitable as a means of temporary improvement, but for permanent improvement a resort to efficient drainage—and that of a special kind—is essential. It is strongly recommended that, before incurring any other outlay, a preliminary survey of each area should be made, and the system of improvement determined according to the results of such survey.

PROF. H. G. SEELEY, F.R.S., will begin the summer course of lecture-excursions with the London Geological Field Class at the end of April. The subject of the series will be the Physical Geography and Geology of the Thames and its Tributaries. This is the eleventh annual course. Mr. R. Herbert Bentley, 31 Adolphus Road, South Hornsey, N., is the hon. secretary to this society, which gives a systematic course of teaching in the open country.

THE *Proceedings* for 1895 of the Agricultural Research Association, the organ of the Research Station, Glasterberry, Milltimber, Aberdeen, contain reports by the Director, Mr. Thomas Jamieson, on the securing of crops, on the permanence of manure, on the "furrow-system" of sowing grain, on the mechanical conditions of soils as affecting the growth of plants, on the mechanical analysis of soils, and on new manures.

THE Danish Meteorological Institute has recently published a valuable series of observations made in the Isle of Denmark, Scoresby Sound, lat. 70° 27′ N., long. 26° 12′ W. From September 18, 1891, to July 31, 1892, meteorological observations were made every hour, under the direction of Mr. C. Ryder, the chief of the expedition. The mean temperature of the six months from November to April ranged between 1°·4 and – 13°·9 F. From the beginning of May the cold began to diminish, and in July there was only a frost on one day. The absolute minimum occurred on March 7, when the thermometer fell to – 52°, and the absolute maximum amounted to 58° on July 13. The wind was usually very light, while calms were very prevalent, amounting to about 80 per cent. Snow, and occasionally rain, fell on 131 days out of 318; neither hail nor thunderstorms occurred during the period of observation, but fog and mist were very frequent, especially between December and June. Aurora borealis occurred on 142 nights out of 183 between October and March; this phenomenon is made the subject of a special discussion.

THE additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus*, ♂) from West Africa, presented by Mrs. Polini; two Rhesus Monkeys (*Macacus rhesus*, ♀ ♀) from India, presented respectively by Mr. C. Harmer and Mr. C. T. Trevalyan; a —— Boa (*Boa* ——) from Dominica, presented by Mr. W. Weldon Symington; a Barnard's Parrakeet (*Platycercus barnardi*) from Australia, deposited; a Raccoon-like Dog (*Canis procynides*) from Japan, two Elliot's Pheasants (*Phasianus ellioti*, ♂ ♀), two Bar-tailed Pheasants (*Phasianus reevesi*, ♂ ♀) from China, two Rosy-billed Ducks (*Metopiana peposaca*, ♂ ♂) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

THE ROYAL OBSERVATORY AT EDINBURGH.—The new Royal Observatory, which has been in course of erection on Blackford Hill, to the south of Edinburgh, during the last four years, was formally opened by the Secretary for Scotland, Lord Balfour, on Tuesday. A short article in the *Times* reminds us that the observatory owes its origin to the presentation to the Scottish nation by the Earl of Crawford of the splendid collection of instruments in his private observatory at Dun Echt, in Aberdeenshire, which was followed by the appointment of Dr. Ralph Copeland, the superintendent at Dun Echt, as Astronomer Royal for Scotland and Professor of Astronomy in the University of Edinburgh in 1889. As there was not sufficient accommodation for the new instruments in the old buildings on the Calton Hill, it was resolved to erect a new observatory worthy of the nation and of Lord Crawford's munificent gift. A Government grant of £33,000, afterwards increased to £36,000, was obtained, and the Town Council of Edinburgh granted on easy terms a site deemed in all respects suitable, on the eastern crest of Blackford Hill, which possesses exceptional stability, a convenient elevation, and unusual purity of atmosphere, the smoke nuisance intruding itself only in one day out of eighteen.

The buildings consist of the observatory proper, the official residence of the Astronomer Royal, the residence of the assistant astronomers, and subsidiary buildings. The observatory is a T-shaped building, the head of the T facing the north with a frontage of 180 feet, and having at each end a telescope tower, of which the eastern is 75 feet high and 40 feet in diameter, and the western is 44 feet by 27 feet. The former contains the most important instrument in the observatory—a new refracting telescope of 15-inch aperture. The latter contains the reflecting telescope, removed from the Calton Observatory, which has an aperture of 2 feet, and which is to be used in astro-physical researches.

Among the other instruments in the observatory are a meridian circle, 8½ inches in diameter; a self-recording anemometer; an ingenious chronograph; the telescope with which the late Prof. Piazzi Smyth made most of his observations on the Calton Hill; several good spectroscopes; a reversing transit instrument; and the clock, connected by wire with Greenwich, which fires the daily time-gun at Edinburgh Castle and drops the time-ball on the Nelson Monument. Connected with the observatory, there is a well-equipped photographic laboratory, and a library with accommodation for some 30,000 volumes, which is already well furnished with the treasures of the Dun Echt collection.

COMET PERRINE-LAMP.—The Perrine-Lamp comet was observed at the Astro-Physical Observatory, South Kensington, on the 1st inst., and spectroscopic observations were made by Mr. Shackleton. On account of the faintness of the comet the spectrum was weak, but a fair amount of continuous spectrum was seen, with three maxima in the green blue, which in all probability correspond to the carbon bands, as they had the same relative positions; this, however, could not be verified by direct comparison.

BOGGIANI'S RECENT EXPLORATIONS AMONGST NATIVE TRIBES OF THE UPPER PARAGUAY RIVER.

THE country along the upper course of the Paraguay has recently been attracting the attention of men of science. A short time ago naturalists were aroused by the wonderful discovery made by Dr. Bohls of *Lepidosiren paradoxa*, that rarest and strangest of fish, living in abundance in lagoons in the Lengua territory of the Gran Chaco, not very far from the right bank of the Paraguay.

I now intend to give a short account of the ethnological results of the explorations of an Italian artist, Cavaliere Guido Boggiani, who, little more than three years ago, lived amongst two of the less-known native tribes, further north, on both sides of the Paraguay River. They are the *Chamacocos* and the *Caduveos*. Boggiani brought home extensive ethnographical collections from both, which he has described in lectures delivered at Rome and Florence, recently published in elegant

and richly illustrated monographs, in which much new information is given on those two previously ill-known tribes.[1]

The *Chamacocos*, of whose singular long-handled stone axes and stone chisel I published an account some years ago in the *Archives internationales d'Ethnographie* of Leyden, inhabit the neighbourhood of Puerto Pacheco, on the right bank of the Paraguay River, now ceded back to Bolivia, their territory lying between 20° and 21° S. lat. They are, however, true nomads, and wander north and south along the main river, but generally from that inland. Their affinities appear to be with the lost *Zamucos*, who formed part of the Chiquitos confederate missions, which flourished about 150 years ago; but up to a quite recent date (*circa* 1885), the *Chamacocos* were quite unknown. The origin of this name is obscure; it is not that by which the tribe calls itself, if such a collective name exists.. Boggiani found that the names *Múria*, *Ibitéssa*, and *Ennima* were given to sections of the tribe.

The first Hispano-American settlers at Puerto Pacheco, who dubbed the natives as *Chamacocos*, became aware of the existence inland of a wilder people, whom they called *Chamacocos bravos*. These were not infrequently raided upon by the *Chamacocos manzos* (*i.e.* civilised), who carried off their children to sell as slaves, and pillaged their camps. Boggiani has found out that this is a kindred but distinct tribe from the *Chamacocos*, speaking a different language; their true name is *Tumanà*, and it appears that the singular long-handled stone axes, which have come into European hands through the *Chamacocos*, are mostly, if not all, taken from them. Further inland, beyond the *Tumanà*, Boggiani was informed that an agricultural settled tribe, the *Tinnàru*, lived, in whom he suspects the real descendants of the *Zamucos* may be found.

The Bolivian settlement at Puerto Pacheco was formed in 1885; it had hardly begun to prosper when the Paraguayans took possession, and re-named the place Bahia Negra. A few years later, Boggiani and an Argentine friend got a concession from the Paraguayan Government, and formed two wood-felling stations in the neighbourhood. It is thus that my friend came in contact with the *Chamacocos*, most of his workmen belonging to that tribe. Boggiani's descriptions of the country and the natives are vivid, the fruit of a refined artist's genuine admiration of a virgin country and wild men. These he depicts as splendid specimens of humanity; tall, perfect in shape, with skin of a bronzed reddish tinge; long black hair, worn tied in a knot behind, in a thick queue, ornamented with feathers, or flowing loose. The women, who, as usual amongst savages, are the beasts of burden, are less handsome, and wear their hair short. No clothing is worn by either sex, except rough sandals of Peccary skin when on the tramp, and a profusion of feather ornaments and necklets of seeds, &c., on festive occasions. As most of the natives of tropical America, the *Chamacocos* excel in the "Arte Plumaria," and it would be difficult to describe in words the beauty of their combinations of bright-coloured feathers of the parrots, toucans, and trogons, with the grey of the rhea, the glossy black of the musk duck, the lovely pink of the spoonbill, and the white plumes of the egrett. Amongst other curious ornaments, one of the strangest is the rattle of the *Crotalus*, for which these people have quite a predilection; for I have seen it dangling amongst feathers in diadems, armlets and leglets, united in bunches as ear-pendants (Fig. 1), and even tied on axes or clubs. I have never heard of other American tribes putting the caudal appendage of the dread rattlesnake to such use. During their dances the *Chamacocos*, besides small gourds containing stones, use belts made with loosely-strung carapaces of small tortoises, or the hoofs of stags. They make rude pottery with the hand, the potter's-wheel being quite unknown to them.

Formerly the *Chamacocos* lived in constant dread of the *Mbaya* or *Caduveos*, then a powerful predatory tribe, located on the opposite side of the Paraguay River, but who frequently raided the Chamacoco territory, carrying off young men and women as slaves. Now the white man, with his diseases and evil propensities, is their worst foe. Boggiani, however, appears to have been a general favourite with them. From his descriptions, the *Chamacocos* appear to be, on the whole, an inoffensive and happy people, and show off their exuberant spirits in frequent dancing and singing bouts. They have various games, one of which may be described as a kind of lawn tennis.

[1] Guido Boggiani. "I Ciamacoco, Conferenza" (Roma, 1894): "Viaggi di un artista nel l'America meridionale, I Caduvei" (Roma, 1895); "I Caduvei, studio" (Roma, 1895).

Besides the singular stone axes with long, flat hard-wood handles, which appear to belong properly to the *Tumanà*, are called *Nò scico*, and may be considered more like war-clubs than cutting implements, the weapons of the *Chamacocos* are plain clubs, wooden spears, large bows for shooting arrows pointed with hard wood, and small bows with a double string, used for shooting clay bullets; these for catching birds.

The women make neat bags and reticules of different kinds of netting, also hammocks, used generally for wrapping and carrying larger parcels. The *Chamacocos*, like most savages, make fine cord of various kinds, using mostly the fibres of the *Ybira*: the weaving loom is unknown to them. Their food is heterogeneous, but they have curious superstitions regarding some kinds; thus deer-flesh is only eaten by men, whilst women can feed on birds and small game; children cannot partake of the eggs of the ostrich (*Rhea*). Boggiani has also collected a small vocabulary of the hitherto unknown language of these people.

Boggiani spent two months and a half with the *Caduveos* of the Nabilecche River, mostly at their principal village Nalicche, living as one of them, and enjoying most favourable opportunities for studying the manners, customs, and character of this once powerful and partially civilised tribe, now sorely reduced in numbers and on the wane. It is strange how little has hitherto been known of them and of their country, so much so that even on recent maps the Nabilecche, which runs into the main stream of the Paraguay River some 10 or 12 kilometres north of Fort Olimpo, in Brazilian territory, is not only misplaced but considered a mere branch of the Paraguay. Nalicche is not on the

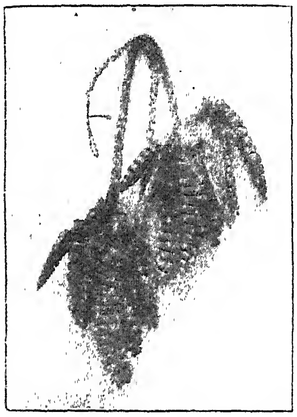


FIG. 1.—Chamacoco ear-pendants of rattlesnake tails.

banks of the Nabilecche, but some distance inland, half way to the Miranda mountains. It consists of a single row of huts slightly bent, united under a common roof of *Yatai* palm-leaves; at the back, separated by boards, are the true huts; the front forms a kind of covered corridor, continuous right through. In front is a square, kept quite clean, at the lower end of which is a spring, which gives the water supply to the village. The country around is a fine wooded and grassy undulated plain, on which the cattle and horses of the *Caduveos* graze. In cleared portions of the adjoining forest are the fields, in which each family cultivates the necessary crops of mandioca, maize, rice, gourds, and sugar-cane, besides papaws and bananas. Poultry and numerous mangy cur-like dogs complete the list of domesticated animals.

The *Caduveos* are known also under the names of *Mbayas* and *Guaycurù*: this last is erroneous, it is the Guarany for "savage." Boggiani believes that they came across the Chaco, and were once in contact with the civilised tribes of Peru; I can hardly follow him as far as that. It is evident, however, that amongst the surrounding wild nomadic tribes the *Caduveos* emerged as a warlike but agricultural people, with fixed residences and certain industrial arts, such as weaving and pottery; in this they excel even to this day. The beauty and variety of their ornamental designs is truly wonderful; Boggiani, as an artist, was particularly struck with this remarkable development in a savage people, and he gives quite a series of fine drawings in illustration of the artistic taste and invention of the *Caduveos*, to be seen on their earthenware and in their very elaborate body and face

painting. As Boggiani justly observes, the decorative art of the *Caduveos* is not the casual result of a complication of rude and primitive designs, but that of a logical study of the harmony and æsthetic combination of lines and figures.

Boggiani, after a long and careful comparative study of the ornamental designs of the *Caduveos*, comes to the conclusion that they show distinct affinities with ancient Peruvian art. In a paper read in September last, at the Italian Geographical Congress,[1] he gives a very interesting account of ornamental designs found on the skin of Peruvian mummies, and comes to the opinion that they were painted, not tattooed, the designs and the process being similar to that practised by the modern *Caduveos*, who stain their skin with the juice of the *Genipa* in ornamental designs of a blue-black colour, which penetrates partially the epidermis, and is sufficiently durable, lasting six or seven days; as the staining process of Genipa-juice, darkening by the action of light, is rather slow, powdered charcoal is added to heighten the effect. The instruments used are small sticks, to the end of which a tuft of cotton-wool is in certain cases tied; the artists are women. A red dye is obtained from the well-known *Urucú* or *Bixa orellana*, but it is far less durable. The *Caduveos* paint thus the feet and lower part of the legs, besides the face; the designs vary *ad infinitum*.

Boggiani describes the *Caduveos* as tall and well-made, of a light bronze colour; the hair is worn short and well combed and greased; the upper incisors are filed to a point; depilation is scrupulously practised. They are cleanly, often bathing and washing their bodies. The men wear a piece of cotton cloth from the waist downwards, held by a belt, richly decorated; the women have, besides, an upper garment covering the breast. Often both men and women have also a kind of *poncho*, which hangs from the shoulders, leaving the arms free. Necklaces, bracelets, and ear-pendants of beads or silver tubes are universally worn; they make their silver ornaments with skill and taste. The men smoke tobacco in cigarettes or in wooden pipes, tastefully carved in wood; the women only chew tobacco. The *Caduveos* were not many years ago skilful weavers of cotton cloth; at present the advent of cheap cotton textiles from Europe has virtually destroyed the native art. Boggiani was, however, able to secure some specimens, and the weaving and spinning apparatus.

As I have noted already, it is in the potter's art that the *Caduveos* excel; it is also the work of women; the ornamentation is rich, varied, and quite peculiar. The designs are traced on the unbaked clay with a cord; red is obtained with oxide of iron, black with the resin of *Palo santo*, white with a kind of chalk. The earthenware of the *Caduveos* presents a large variety in shapes and sizes. The only neighbouring tribe who do anything of the kind are the *Guanà*, but their ware is inferior in all respects.

The *Caduveos* now possess European weapons; bows and arrows are, however, yet in use for the chase and for fishing. Boggiani was able to secure a few rough stone axes, but they were designated as "sky stones," and used for crushing nuts. The *Caduveos* have canoes or dug-outs of different sizes, which they manage with skill. The chiefs, and their descendants also in the female line, form a sort of nobility, now more numerous than the commoners; the lower caste is formed by slaves, often the descendants of captured *Chamacocos*. The head chief is called *Mbaya*, a name which is also applied to the whole tribe; his authority is not great, and much freedom exists amongst the heads of families; even the slaves are well treated, and often ultimately are considered free. One wife is married, and the bridegroom goes to live in the house of the bride, taking with him the family poles, which are driven in the ground in front of the sleeping-place of the newly-married couple; these poles are carved with totemistic designs.

Fig. 2.—Caduveo decorated pottery.

The *Caduveos* are at present much reduced in numbers, and Boggiani foresees their speedy extinction. Many are the causes which have led to this, derived from the contact with the whites; but it must not be forgotten that abortion and infanticide are, unfortunately, but too frequent amongst the *Caduveo* women, who only care to rear one child. They are, besides, cursed with the red man's love for strong drinks. Otherwise they are gay and sociable, delight in dances to the sound of drum and flute, and in a game very much like golf; pugilistic bouts, *coram populo*, are also in great favour, in which men, women and children join.

The *Caduveos* have medicine-men or sorcerers, who monopolise the spiritual and mystic rites, and effect cures. One, whom Boggiani saw practising with a piece of a glass mirror and a bunch of feathers on a dark night, was a *Chamacoco*.

Boggiani writes well, he is a careful observer, and has proved himself an excellent collector; he is to be sincerely congratulated on the good work he has hitherto done for ethnology, and we cannot but cordially join in the hope he expresses of being able to continue and complete his investigations of the native tribes of the Northern Chaco and adjoining regions.

Henry H. Giglioli.

[1] G. Boggiani, "Tatuaggio o Pittura? Studio intorno ad una curiosa usanza delle popolazioni dell' antico Peru." Atti del II° Congresso Geografico, Roma, 1895.

A NEW HUMAN SKULL OF A LOW TYPE FROM BRAZIL.[1]

A LOW type of human skull has recently been described by Prof. A. Nehring, which was found near Santos, in Brazil. It occurred in a breccia ("sambaqui"), the exact age of which is uncertain, associated with fish vertebræ, a portion of the lower jaw of a toothed-whale, and a few fragments of other human remains and implements.

The principal measurements given are the maximum length (183 mm.), maximum breadth (135 mm.), minimum frontal (88 mm.), maximum frontal (92 mm.), frontal sagittal arc (118 mm.), and the parietal arc (134 mm.) The cephalic index is thus 77·6. Virchow has also described two skulls from a sambaqui near Santos, with indices of 82 and 79·8; while de Lacerda measured three male skulls from sambaquis in Parana and Santa-Catherina, with the indices of 67, 68·8, 77·2, and two female skulls with 79·7 and 81·4. There is thus great variation among these people, which Nehring regards as individual or partly sexual, and not due to ethnical mixture.

The forehead is low and retreating, the glabella and orbital ridges well developed, and the frontal is greatly constricted behind the orbital region, as in Pithecanthropus. This constriction is also very characteristic of ancient and recent South American skulls (Peixoto and de Lacerda), some of which are absolutely and relatively not broader than Pithecanthropus.

Dr. Nehring, from his studies on the skulls of both sexes and various ages of anthropoid apes and of dogs of different breeds, is of the opinion that the occurrence of a constriction between the orbital and cerebral portions of the skull has direct relation to the strength of the head musculature, and more especially of the jaw muscles. If the skull of a muscular Eskimo dog be compared with that of a pug or a Bolognese lap-dog, it will be found that this constriction is very marked in the Eskimo dog, the zygomatic arches of which are widely outstanding, and all the muscular attachments strongly developed; but the constriction is scarcely noticeable in the pug, and is entirely wanting in the Bolognese lap dog; the two latter exhibit feminine rounded forms of the corresponding parts of the skull, with a feebly developed musculature.

The author compares human skulls with those of middle-aged female chimpanzees and gibbons, and finds a great similarity in the constriction of their respective frontal bones. He justifies this comparison by pointing out that the human skull always remains in a juvenile stage, while that of the ape, especially the male, is strongly modified by the jaw and neck muscles. The human condition is accounted for by the erect position, with the consequent balancing of the skull on the vertebral column, and the reduction in the dentition owing to the artificial preparation of food. According to Nehring, the constriction of the orbital portion from the cerebral portion of the skull of Pithecanthropus does not prove a simian origin.

The face of the sambaqui cranium is strongly prognathous; perhaps this is increased by an abnormality in the arrangement of the teeth, there being seven upper incisors, of which two are placed behind the others, and the third is in the middle of the normal series and has a curious curve on its anterior aspect. Only one of the normal teeth is slightly displaced. Nehring does not regard these as persistent milk-teeth, but as supernumerary teeth.

The whole dentition is strong, in fact it is one of the most powerful of known human dentitions, and the two molar series are parallel to each other, and are not in the form of a horse-shoe. All the teeth are perfectly sound.

The dimensions of the pre-molars and molars come very close to those of Spy No. 1 skull, any difference there may be being in the direction of the dentition of Spy No. 2; thus we find that the exceptional size of the wisdom-teeth in the Spy skulls is also characteristic of the sambaqui cranium.

While the length-breadth dimensions of the new skull agree fairly closely with those of Pithecanthropus, the cranial height is considerably higher, and consequently the capacity, if it could be measured, would be much greater. Looked at from above, the skull is better filled than that of Pithecanthropus, both posteriorly and in the anterior temporal region; there is also a marked difference between the orbital portion of the frontal bone, which somewhat resembles that of the Neanderthal calvaria, and the flat projecting character of that region in Pithecanthropus erectus.

A. C. Haddon.

[1] Prof. A. Nehring: "Menschenreste aus einem Sambaqui von Santos in Brasilien, unter Vergleichung der Fossilreste des Pithecanthropus erectus Dubois." *Verhandl. Berliner anth. Gesellsch.*, 1895-6, p. 710.

THE SURFACE-DIMENSIONS OF AN EARTHQUAKE-PULSATION.

IT is now well known that the effects of a great earthquake are not confined to the more less limited area over which it is perceptible to human beings, or capable of disturbing seismographs. With suitable instruments, the oscillations may be traced for thousands of miles, and there is no reason whatever for doubting that in the future they may be traced (possibly several times) completely round the globe. As to the exact nature of the pulsations, we are still in partial ignorance; but part of the movement certainly consists of a real tilting of the surface of the ground. Prof. Milne regards earth-pulsations as long, low waves, somewhat resembling an ocean-swell; and the object of this short note is to show that, in one case at any rate, his view is correct.

On April 27, 1894, a severe earthquake occurred in North-east Greece, and the pulsations were observed in Birmingham with one of Mr. Darwin's bifilar pendulums (Nature, vol. l. pp. 7, 246–9). The average period of the pulsations was fourteen seconds, and the maximum change of inclination of the ground in the east and west direction was not less than one-quarter of a second. A comparison of the times at Athens, Birmingham, and other places, shows that the velocity of the first large pulsations was nearly constant, and equal to 3·21 km. per second.

Assuming the form of a right section of the pulsation to be a simple harmonic, the length of a complete pulsation is vt km. where v is the velocity in km. per second, and t seconds the duration of its period. The amplitude of the pulsation, *i.e.* the height of its crest above the position of equilibrium, is easily shown to be $\alpha vt/6^4$ metres, where α seconds is the maximum tilt of the ground with reference to a horizontal plane. In the case of the Greek earthquake, we have $t = 14$, $v = 3{\cdot}21$ and α not less than $\frac{1}{8}$. These figures show that at Birmingham the length of a pulsation must have been 45 km., and the height not less than 4·4 mm.

The estimate of the height is not great enough for two reasons: (1) owing to its suspension in oil, the mirror of the pendulum was unable to perform its full swing during the brief period of the pulsation; and (2) the pendulum showed only the component of the tilt in the east-west plane. When the frame of the pendulum is suddenly tilted through an angle of 2″, the deflection of the mirror at the end of a quarter of a minute is only half the correct amount. If, therefore, we multiply the above result for the height by 3, we shall probably be not far from the true value.

Thus, translated into ordinary units, the largest pulsations of the Greek earthquake at Birmingham must have been about 28 miles long and half an inch in height.

Charles Davison.

SCIENCE IN THE MAGAZINES.

WITH an article on "The Evolution of the Professions," Mr. Herbert Spencer concludes the series of papers on professional institutions which he has been contributing to the *Contemporary* for some months. The fact which the whole of the papers have aimed at showing, and which is illustrated by the present article, is that society is a growth, and not a manufacture, and has its laws of evolution. "From Prime Ministers down to ploughboys," we read, "there is either ignorance or disregard of the truth that nations acquire their vital structures by natural processes and not by artificial devices. If the belief is not that social arrangements have been divinely ordered thus or thus, then it is that they have been made thus or thus by kings, or if not by kings then by parliaments. That they have come about by small accumulated changes not contemplated by rulers is an open secret which only of late has been recognised by a few and is still unperceived by the many—educated as well as uneducated." In support of this law of the evolution of society, Mr. Spencer cites numerous instances drawn from agriculture, manufactures, commerce, and various professional institutions where advancement has been achieved by spontaneous co-operation of citizens, and not by legislative direction. We have "knowledge developing into science, which has become so vast in mass that no man can grasp a tithe of it, and which now guides productive activities at large, has resulted from the workings of individuals prompted not by the ruling agency but by their own inclinations." So, and in like manner, it is held that the unprompted workings of humanity, and not time-serving legislation, are responsible for real social progress.

Prof. James Sully contributes an amusing article to the *National Review*, on "The Humorous Aspect of Childhood." Some of the stories he tells in illustration of the simplicity and openness of child-nature deserve repetition here. The little boy who, in describing a fat lady, said she was just like a seal, used a singularly appropriate simile; for the human figure bereft by its obesity of the neck and waist divisions does grow seal-like. Then the purely arbitrary character of many of our language-forms affords opportunities for such remarks as that of the small boy who spoke of Charles the First's body having been cut off from his head. Another example of this childish tendency to rearrange things is supplied by the remark of a boy of five, who being asked whether the baby was christened, answered with alacrity, "No, she isn't christened, but she's vaccinated." Children are entirely anthropomorphic, believing that things about them have some mysterious relation to them. This is exemplified by the story of a child who quaintly remarked to an older child that seemed frightened on hearing about earthquakes, "They don't have earthquakes in little towns like this." Prof. Sully remarks on this: "The words suggest that the little comforter conceived of the earthquake as something which was specially designed for human spectators, to throw them into cold shudders, or possibly to electrify them with the delicious excitement of danger, according to their temperaments, and which would not therefore be brought on the scene where there was not a full house, so to speak. The saying seems to me full of the characteristic quaintness of child-thought. It is so deliciously comical to us who know, or fancy we know, what these alarming oscillations of the earth's surface really are, to have them thus turned by the naive conceit of the child-mind into a kind of show. Yet may we not here too detect an exaggeration of something in older people's thought about the universe, and in smiling at the crudity of the child's whimsical fancy be half-quizzing our own occasional lapses from the perfectly detached and unimpassioned point of view of science?" All who are interested in child-thought and child-observation should read Prof. Sully's collection of stories. The pity of it is that our educational system should so effectually crush the faculties of quick and acute observation and logical reasoning possessed by children.

Prof. John Trowbridge describes experiments with Röntgen rays in *Scribner's Magazine*, under the title "The New Photography by Cathode Rays." He refers to the new actinic rays as "cathode rays" throughout his article. An interesting illustration accompanying his article is a double picture of the Röntgen shadow of a turkey's wing, taken by rays from two cathodes slightly separated from one another. By measuring the distance between the double images, the depth of the shot can be estimated by triangulation.

Among the articles of minor scientific interest, we notice one on the boundary dispute between Great Britain and Venezuela in the *National*, by the editor, Mr. L. J. Maxse. This is accompanied by two maps from the recent Venezuela Blue-book. In *Longman's*, Mr. Fred Whishaw has a sympathetic paper on life in a pine-forest in winter. *Chambers's Journal* has its usual complement of information articles, the most noteworthy being on "Toad-Lore," "Modern Gunpowder and its Development," "Pets and Pests in Barbadoes," and "Bird-Catching in Heligoland." The *Humanitarian* has two papers on "University Degrees for Women," in one of which Dr. A. W. Verrall states the case for degrees, while Mrs. B. J. Johnson writes for the opposition. In the *Strand Magazine* is an instructive account of "Diamond Mining in South Africa," by Mr. J. Bucknall Smith. Finally, scientific phonographers will find much to interest them in the clearly-printed pages of the *Phonographic Quarterly Review*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The Education Bill of Sir John Gorst, to which reference has already been made in these columns, makes, it is true, several provisions for secondary education, but it can hardly be supposed that the comparatively few recommendations under this heading are to be the only outcome of the prodigious labours of the recent Commission. The county education authority, the constitution of which was explained in a note last week, may, amongst other matters, aid any school in the provision of secondary education, or, with the consent of the Education Department, may take a transfer of any secondary school. It may also establish such schools; found and maintain scholarships or exhibitions; supply, or aid in supplying, teachers; make inquiries with respect to the sanitary condition of the school-buildings (including boarding-houses) of any school within their county; and make inquiries with respect to the education given by any school within their county. Schools which in the opinion of the Education Department are of a non-local character are, however, excepted. The education authority may then take such measures as they think fit for giving information to the public with respect to the result of such inquiries. The county education authority is to be given power to *aid* any establishment or organisation for the training of teachers, but there seems to be no provision for the formation of new training schools or colleges. Provision is made for the transfer of higher grade board schools to the county authority, either at their own request or that of the School Board concerned. If the education authority desire, they may make it one of the conditions of any grant to a secondary school that representatives of the authority be added to the trustees or governing body of the school. The consent of the trustees being given, such representatives will become for all purposes members of the governing body of the school. It is further arranged that the amount which can be raised under the Technical Instruction Act, 1889, shall not be exceeded. One satisfactory point is that, in the event of this Bill becoming law, it will be impossible to have any further diversion of the money available under the Local Taxation Act, 1890, to purposes other than those of education. These funds are, moreover, to be in the future available for all degrees and kinds of secondary education, and not only for technical instruction.

At the meeting of the Manchester City Council, held on Wednesday, April 1, Mr. Alderman Hoy reported that the Co-ordination Sub-committee of the Technical Instruction Committee had been dissolved. This Sub-committee was composed of representatives of the principal educational institutions in that city, and has been successful in arranging for the better co-ordination of the spheres of work of these institutions, and has so prevented over-lapping. It has been successful in bringing the School Board into line with the work of the Committee specially concerned with technical education, and has done very valuable work in other ways. We hope to see other large towns following the example thus successfully set by Manchester, for it is certain that by friendly conferences of this sort the best results for education will be obtained. It has been decided to appoint an Advisory Committee in the place of that dissolved, which will comprise the Chairman of the Technical Instruction Committee (Mr. Alderman Hoy), the Chairman of the School Board, the Principal of Owens College, and the High Master of the Grammar School. This Sub-committee will have power to call together the General Committee whenever they deem it necessary in view of any educational emergency.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. ii. No. 6, March 1896.—"The three great problems of antiquity considered in the light of modern mathematical research" is a review, by Miss C. A. Scott, of Prof. Klein's Festschrift for the third meeting of the Association for the Advancement of Mathematical and Scientific Teaching in the Gymnasia, entitled "Vorträge über ausgewählte Fragen der Elementargeometrie." Of course the problems intended are the duplication of the cube, the trisection of an angle, and the quadrature of the circle. The pamphlet is divided into two parts: the first deals with algebraic numbers, the second with transcendental numbers. The analysis is very full, so that the reader gets a thoroughly good idea of Prof. Klein's work. "But while reading this brilliant exposition it is difficult to avoid cherishing a lurking regret, which is possibly very ungracious, that Klein could not himself spare time to arrange his work for publication; for though we have here in full measure the incisive thought and cultured penetration which together make even strict logic seem intuitive, yet at times we miss the minute finish and careful proportion of parts that we feel justified in expecting from him. And yet revision and consolidation might have seriously interfered with the graphic simplicity of these chapters, and left them less adapted to their special purpose." From Miss Scott's account we are thoroughly disposed to endorse her wish that the

pamphlet should be translated for the use of corresponding English associations. Why should not she undertake the task, if she has the leisure?—Prof. A. S. Chessin gives an abstract of Painlevé's Leçons sur l'intégration des équations differentielles de la Mécanique et Applications, and of his Leçons sur le Frottement.—The other articles are a geometric proof of a fundamental theorem concerning unicursal curves, by Prof. Osgood; Notes on the expression for a velocity-potential in terms of functions of Laplace and Bessel, by Prof. J. McMahon, and an additional note on divergent series by Prof. A. S. Chessin.—In the Notes we are told that the German Mathematical Society, at its meeting held at Lübeck, in September last, decided to combine in one volume the official reports of the Vienna and Lübeck meetings.—A list of papers, in addition to that given in vol. i. of the *Bulletin*, completes the tale of papers read at the Vienna meeting (1894), and the titles and names of authors for the Lübeck meeting are also given here.

American Meteorological Journal, March.—The diurnal oscillation of atmospheric pressure at the Peruvian stations of Harvard College Observatory, by Prof. S. I. Bailey. (A note upon this paper will be found in our issue of March 26, p. 493).—Cyclones and anticyclones, by Prof. H. A. Hazen. The author gives an epitome of the theories and researches of the principal investigators, and makes a special appeal for further atmospheric exploration. He considers that the most promising line of research is in connection with the observation of atmospheric electricity, and some useful hints are given with reference to the most promising means of increasing our knowledge by observations on high mountains and balloons, either manned or carrying recording instruments only.

Himmel und Erde, March.—This number contains many attractive contributions.—Herr Paul Spies writes on the Röntgen X-rays, this article being the sum and substance of a lecture delivered by him in the Urania at Berlin. Johann Christian Doppler and the "principle" connected with his name is the subject treated of by Dr. Julius Scheiner. That which is generally known about Doppler's life has been drawn from the biographical notice contained in the almanack of the Kaiserl. Akademie der Wissenschaft in Wien, which was written by the, then, general Secretary of the Academy, Prof. Strotter. With the help of Prof. Safarik, Dr. Scheiner is here able to increase our information on many points of interest, by publishing for the first time some characteristic notes gathered from Prof. Koristka, of the German Polytechnic in Prague.—The *Mitteilungen* contain several astronomical notes. A reference, with an illustration, is made to the Fabricius monument which was erected at Osteel last November. This monument consists of the goddess of astronomy in a sitting position, and looking towards the sky, holding in her right hand a small telescope, and supporting with her left a tablet on which in relief is seen the solar disc with some spots on his surface. The time of rotation of Jupiter and the cosmical origin of meteors form subjects for the next two notes, the latter referring more especially to Niessl's investigation, which appeared in the *Denkschriften der Wiener Akademie*. Two other notes refer to the "Internationale Erdmessung" and to the possible inconstancy of the length of a day, this latter having been raised by Prof. Deichmüller, who considers that very small secular variations may be present, although they have not as yet been detected.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 19.—"On the Spinal-root Connections and Ganglion-cell Connections of the Nerve-fibres which produce Contraction of the Spleen." By Prof. E. A. Schäfer, F.R.S., and B. Moore.

We have investigated, in four dogs, the effects upon the spleen volume of excitation of the thoracic and lumbar nerve-roots.

The following are the results which we have obtained from excitation of the nerve-roots from the second postcervical to the fifteenth postcervical inclusive. In none of the four experiments did excitation of the *second* postcervical (second dorsal) pair produce any contraction of the spleen. In none of the four experiments did excitation of the *fifteenth* postcervical pair produce any contraction of the spleen. In three out of the four experiments a distinct contraction of the spleen was got on stimulation of all the roots on both sides from the third postcervical to the fourteenth postcervical inclusive. This effect was relatively smaller on stimulation of the third and fourth postcervical nerves and of the eleventh to the fourteenth postcervical than on stimulation of the intermediate pairs, the most marked effects being obtained from the sixth, seventh, and eighth pairs. In all cases the effect was got, as already stated, from the nerve-roots of *both sides*, but with each nerve pair it comes out as an almost constant occurrence that a decidedly less marked effect is obtained with the same strength of stimulus upon the right side than upon the left.

We have found that after intravenous injection of small doses of nicotine, the effect upon the spleen of stimulating the nerve-roots may entirely disappear, while stimulation of the splanchnics is still quite effective. We infer, therefore, that the nerve-fibres which produce contraction of the spleen have a cell station in the prevertebral chain of ganglia.

"Problems in Electric Convection." By G. F. C. Searle.

The paper contains an investigation into the distribution of electric and magnetic forces which are called into play when some electro-magnetic systems are made to move with uniform velocity through the ether. Maxwell's theory is employed in obtaining the fundamental equations, and it is found that though the electric and magnetic forces, E and H, have generally no potential, still they can be derived from two functions Ψ and Ω; the differential equations satisfied by these functions are obtained, and are employed to obtain the solutions for various cases and conditions.

Zoological Society, March 17.—Prof. G. B. Howes in the chair.—Mr. Sclater called the attention of the meeting to the prospectus of the great work of the German Zoological Society, to be called "Das Tierreich," spoken of at the last meeting, and gave some particulars as to the mode in which the plan was intended to be carried out. Mr. Sclater also called attention to the appointment of a Committee on Zoological Nomenclature at the International Zoological Congress held at Leyden last year.—A communication was read from Lieut.-Colonel C. T. Bingham, containing a contribution to the knowledge of the hymenopterous fauna of Ceylon.—A communication was read from Mr. Edward T. Browne, on British Hydroids and Medusæ. Mr. A. Smith Woodward read a paper on some extinct fishes of the Teleostean family Gonorhynchidæ.

Entomological Society, March 18.—Prof. Raphael Meldola, F.R.S., President, in the chair.—Mr. C. G. Barrett exhibited a series of drawings of varieties of British Lepidoptera in the collection of Mr. S. J. Capper, of Huyton Park, Liverpool. The drawings, which were beautifully executed, were by Mr. S. L. Mosley, of Huddersfield, and comprised 389 figures, representing 139 species, of which 33 were butterflies and 50 moths.—Mr. J. J. Walker, R.N., exhibited a specimen of *Procas armillatus*, taken on Durland Hill, near Chatham, during the present month.—Herr Jacoby exhibited a specimen of *Loxoprosopus ceramboides*, Guér., from Brazil.—Mr. E. E. Green exhibited the eggs of some species of Locustidæ extracted from the stem of a young cinchona tree at Punduloya, Ceylon. He said the species of the parent insect was undetermined; it was possibly either a *Cymatomera* or a *Cyrtophyllus*, both of which possess large sabre-shaped ovipositors. A slit half inch deep and more than two inches long had been cut into the hard wood, in which the eggs had been symmetrically deposited, edge to edge, with the coloured part inwards. The greater part of each egg was of fine texture, and coloured green; but at the extremity from which the young insect would make its exit the egg-shell was soft, pliant, and beautifully reticulated. Mr. McLachlan and Dr. Sharp, F.R.S., made some remarks on the subject.—Mr. Green read a short paper entitled "Notes on *Dyscritina longisetosa*, Westw." He remarked that drawings of the species had been exhibited by him at a recent meeting of the Society. Dr. Sharp said Mr. Green seemed to think that the insect was an earwig, but he could not accept it as belonging to the Forficulidæ. He thought that further specimens for examination were required before attempting to determine its position, which was quite doubtful at present.—Mr. W. F. H. Blandford communicated a paper entitled "Descriptions of New Oriental *Scolytidæ*."

Linnean Society, March 19.—Mr. C. B. Clarke, F.R.S., President, in the chair.—Mr. Clement Reid exhibited fruits of *Naias marina* from a peaty deposit below mean-tide level in the new docks at Barry, South Wales. In Britain it had only been found living at a single locality in Norfolk, but in a fossil con-

dition it had been obtained in the pre-glacial forest-bed at Cromer.—Mr. Clement Reid also exhibited some wood forwarded by Mr. H. N. Ridley from the jungle near Singapore. It appeared to have been eaten into a honeycombed mass of peculiar character, and was found only in wet places, but always above ground, the entire tree rotting. Neither Mr. Ridley nor Mr. Reid had seen anything like it in England; and the latter, while suggesting that the small lenticular unconnected cavities in the wood were probably caused by insects or their larvæ, thought they were unlike the work of either beetles or white ants.—A paper was read by Dr. Otto Stapf on the structure of the female flowers and fruit of *Sararanga*, Hemsley. The materials utilised consisted of female flowers and fruits of *Sararanga sinuosa*, Hemsley (*Journ.* Linn. Soc., vol. xxx. p. 216, t. 11), which had been collected by the officers of H.M.S. *Penang* in New Georgia, Solomon Islands, and were in excellent preservation. There were also photographs and a description, taken upon the spot, of the tree, about 60 feet high, shortly branched at the top, with terminal, nodding, white-flowered, very compound, and gigantic panicles. The leaves are like those of an ordinary screw-pine. The flowers consist of a rudimentary, sinuously bent, saucer-shaped perianth, and a sub-globose, sinuously lobed gynæcium, with very numerous (70–80), dark, discoid, or reniform stigmas which are arranged in double rows over the dorsal ridges of the main body and the lobes, having between them minute pores which end behind some way below the surface. There are as many ovary-cells as stigmas, each containing one anatropus ovule from the base of the inner angle. The vascular bundles of the gynæcium end below the stigma in a cluster of tracheids, and supply it probably with a viscid or sugary liquid. The base of the pore is surrounded by a compact, thin-walled parenchyma, very rich in plasma. It is suggested that the pollen-tubes grow from the stigma down into the pore, and descend from here through the conductive tissue to the ovule. The ripe fruit is a succulent drupe with numerous pyrenes, in shape like the flower, but much larger. The endocarp is bony, the albumen copious and oily; the embryo is as in *Pandanus*. The complex structure of the flower is explained as a modification of the type represented, *e.g.* in *Pandanus utilis*, and in accordance with Count Solms-Laubach's theory of the flower of the Pandanaceæ. On this paper some critical remarks were offered by Mr. Rendle.—On behalf of Mr. G. S. West, a paper was read by Prof. Howes on two little-known Opisthoglyphous Snakes. The author had examined and compared, in respect of the structure of the buccal glands and teeth, specimens of the grooved and non-grooved varieties of *Erythrolamprus æsculapii*, as recorded by Dr. Günther ("Biologia Centr.-Amer.," part cxxi. p. 166), and he proved that the latter were rightly referred to the species.

Geological Society, March 25.—Dr. Henry Hicks, F.R.S., President, in the chair.—On submerged land-surfaces at Barry, Glamorganshire, by A. Strahan, with notes on the fauna and flora by Clement Reid, and an appendix on the Microzoa by Prof. T. Rupert Jones, F.R.S., and F. Chapman. Excavations for a new dock at Barry have disclosed a series of freshwater or slightly estuarine silts with intercalated peats, below sea-level on the north-eastern side of the island. The site of the excavation was overflowed by the tide until the year 1884, when the docks were commenced. The newest deposits seen are, therefore, blown sand, *Scrobicularia*-clay, and sand or shingle with recent marine shells. These rest on an eroded surface of blue silt, with sedges in position of growth. Four peat-beds occur in this silt, at 4, 11, 20, and 35 feet below Ordnance datum respectively. The uppermost peat contains a seam of shell-marl, partly composed of the shells of ostracoda, and partly of *Bythinia*, *Limnæa*, &c. The second is a mass of matted sedges. The third is a land-surface, and in places consists almost wholly of timber with the stools and roots *in situ*. The fourth is also an old land-surface, as is proved not only by the presence of roots in place beneath it, but by numerous land-shells. A fragment of a polished flint-celt was found by Mr. Storrie embedded in the lower part of the uppermost peat. By a comparison with the existing maritime marshes of the neighbourhood, it was shown that the fourth peat indicates a subsidence of not less than 55 feet. The sea encroached upon the area in consequence of this subsidence. It entered by the lowest of three low cols in the southern water-parting of the Cadoxton River, thus isolating the portion of land now known as Barry Island. A slight further movement would have converted the water-parting into a chain of islands.—On a phosphatic chalk with *Holaster planus* at Lewes, by A. Strahan, with an appendix on the ostracoda and foraminifera by F. Chapman. This rock, which occurs at the base of the upper chalk, at the horizon of the chalk rock, does not exceed 1½ feet in thickness, and persists for a few yards only. In composition and microscopic character it presents a close analogy to the Taplow phosphatic deposit, which, however, occurs at the top of the upper chalk. Like it, it consists of brown phosphatic grains embedded in a white chalky matrix. The grains include a large number of pellets, attributable to small fish, phosphatised foraminifera, chips of bone, &c. Fish-teeth also occur in abundance. To complete the resemblance, the Lewes deposit rests on a floor of hard nodular chalk, beneath which is a white chalk traversed by irregular branching pipes filled with the brown variety. Such "floors" were attributed to concretionary action ensuing upon a pause in the sedimentation. The piped chalk was compared with the structure known as *Spongia paradoxica*. It was concluded that phosphatised deposits may occur at any horizon in the chalk; that the phosphatisation is due to small fishes, attracted by an unusual abundance of food; that they are shallow-water deposits, and associated with a pause or change in the sedimentation. Mr. Chapman furnished a list of 42 species and varieties of foraminifera, and 6 species of ostracoda. The former indicate a deeper water origin than do those of the Taplow chalk. He noted the occurrence for the first time in this country of *Gypsina Cretæ*, Marrson.—On the classification of the strata between the Kimeridgian and the Aptian, by Dr. A. P. Pavlow, Professor of Geology in the University of Moscow. In this paper the author discussed the new evidence respecting the palæontology of the Lower Cretaceous and Upper Jurassic deposits of Russia, which had come to light since the publication, by Mr. Lamplugh and himself, of "Les Argiles de Speeton et leurs Equivalents" (Moscow, 1892).

DUBLIN.

Royal Dublin Society, March 18.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—A paper was read on the Röntgen X-rays, by Mr. Richard J. Moss (see NATURE, April 2, p. 523).—Prof. Arthur A. Rambaut read a note on the rotation period of dark spots on Jupiter.—A memoir on the carboniferous Ostracoda of Ireland, by Prof. Rupert Jones, F.R.S., and Mr. J. W. Kirkby, was communicated by Prof. W. J. Sollas, F.R.S.

PARIS.

Academy of Sciences, March 30.—M. A. Cornu in the chair.—On the properties of the invisible radiations emitted by uranium salts, and by the antikathodic wall of a Crookes' tube, by M. Henri Becquerel. The rays given off by uranium salts are doubly refracted by tourmaline, a parallel experiment with a Crookes' tube giving a negative result.—On the variations in the brightness of the star Mira-Ceti, by M. Duménil.—On the inversion of systems of total differentials, by M. P. Painlevé.—Extension of the theorem of Cauchy to more general systems of partial differential equations, by M. E. Delassus.—On the penetration of gases into the glass walls of Crookes' tubes, by M. Gouy. Glass which has been exposed to intense kathodic rays gives off numerous bubbles of gas on heating.—On the use of non-uniform magnetic fields in photography with the X-rays, by M. G. Meslin.—The time of exposure in photography by the X-rays, by M. J. Chappuis. The effect produced by a Crookes' tube upon a gold-leaf electroscope was studied under varying conditions. An increased action was obtained by concentrating the rays by a strong magnetic field, and especially by replacing the ordinary metallic contact-breaker by a Foucault's interrupter.—Action of the X-rays upon electrified bodies, by MM. Benoist and Hurmuzescu. In reply to criticisms by MM. Righi, Dufour, and Borgmann and Gerchun, the authors have repeated their original experiments with additional precautions, and find that the discharge of an electrified body by the rays is complete, and is independent of the sign of the original charge. Different metals appear to be discharged at different rates, a result difficult to explain by the theory advanced by Prof. J. J. Thomson, that dielectrics become conductors under the action of the X-rays.—On the refraction of the Röntgen rays, by M. F. Beaulard. With a prism of ebonite no clear evidence of deviation could be obtained.—On the diffraction and polarisation of the Röntgen rays, by M. G. Sagnac.—Stereoscopic photographs obtained with the X-rays, by MM. A. Imbert and H. Bertin-Sans.—Determination of the exact position of a foreign body in

the tissues by means of the X-rays, by MM. A. Buguet and A. Gascard.—Experiments relating to the action of the X-rays on *Phycomyces nitens*, by M. L. Errera. This *Phycomyces* was not sensitive to these radiations.—On the Röntgen rays, by M. C. Henry. General considerations as to the nature of the rays, and a *résumé* of their properties.—Reply to some observations of M. Henri Becquerel relating to a note "On the principle of an accumulator of light," by M. C. Henry.—Remarks on the preceding, by M. Henri Becquerel.—Safrol and isosafrol. Synthesis of isosafrol, by M. C. Moureu.—On citronnellal and its isomerism with rhodinal, by MM. P. Barbier and L. Bouveault.—On the macroblasts of the oyster; their origin and localisation, by M. J. Chatin.—On the relations between *Lepismina myrmecophila* and ants, by M. C. Janet.—On the tertiary basin of the lower valley of the Tafna, by M. L. Gentil.

Amsterdam.

Royal Academy of Sciences, January 25.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Lorentz showed a number of photographs prepared by means of X-rays by Prof. Röntgen, of Würzburg.—Prof. MacGillavry presented the dissertation of Dr. D. MacGillavry on the actiology and the pathogenesis of congenital defects of the heart.—Mr. Jan de Vries gave applications of the introduction of a third radius vector into the bipolar system, so that the three poles lie in a straight line.—Prof. Schoute treated Steiner's quartic surface $y^2z^2 + z^2x^2 + x^2y^2 = 2kxyz$.—Prof. Engelmann communicated the result of an investigation made by Dr. H. J. Hamburger into the importance of respiration and peristaltics to the resorption in the intestine. The resorption of liquids in the alimentary canal increases with the intra-intestinal pressure, and disappears altogether when this pressure is artificially lowered to 0 or a negative value.—Prof. Kamerlingh Onnes made, on behalf of Mr. D. van Gulik, a communication concerning an investigation made, under the direction of Prof. Haga, at Groningen, into the cause of the variation of resistance in microphonic contacts brought about by electric vibrations. In investigating the cause of the diminution of resistance through electric vibrations generated in bad microphonic contacts, it has been ascertained that the ends of a current-chain, when brought very close together, attract each other if the wires are exposed to Hertz's waves. The arrangements being made with proper care, the movable ends were seen under a microscope to touch each other as soon as electric vibrations were generated near them. The original air-gap must not be larger than four microns, and a contact arisen in this way offered a resistance of $\frac{1}{4}$ Ω to the current. The removal of the element from the chain had no influence upon the phenomenon. When the air-gap was a few microns too large, then small sparks resulted on the wires being acted upon by the above-mentioned waves. Prof. Kamerlingh Onnes, starting from his theorem that Van der Waals's corresponding states are dynamically similar, inferred that the cooling of the gas in Thomson and Joule's porous plug will, according to their experiments with hydrogen (1862), become zero and turn into heating, with all gases, at sufficiently high temperatures. The author extended the theorem to thermo-dynamical similarity, and thus supplied the means to find the dimensions of an apparatus to liquefy hydrogen, if there is given one liquefying oxygen in a satisfactory manner. Linde's and Dewar's methods were considered from this point of view. The author also commented on his endeavours to get a small self-cooling motor, liquefying oxygen, to be used as a model for apparatus to liquefy hydrogen by doing work adiabatically after the manner of Solvay, and intended to form part of a series of theoretically perfect cooling apparatus. Finally the author pointed out the superiority of Dewar's vacuum-jackets, and their great importance for low temperature work.

February 29.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Suringar described, in connection with previous communications, some *Melocacti*, lately received from the island of St. Martin, and belonging to the tribe of *Melocacti communes*. They most nearly approach to the one described by Link and Otto as *M. communis*, var. *macrocephalus*. They represent two types, which speaker has called *M.* (*communis*) *Linkii* and *M.* (*communis*) *croceus*, the name *communis* between parentheses indicating the affinity. From a comparison of the specimens discussed with those the author formerly brought away from St. Eustace, and with the description and drawing by Hooker of specimens from the island of St. Kitts, it appears that in these islands, situated very near each other, distinctly different, constant varieties of the common type have developed themselves. This had induced the author to collect and to critically examine all the older accounts, and especially the drawings by Lobelius (1576) down to Miquel's monograph (1840). In anticipation of the Iconography, which he is preparing, he presented a treatise on the subject, as a fourth contribution to the *Transactions* of the Academy. It treats partly of crook-thorned Melocacti, to which those of Lobelius and Besler belong, and of which the author has found a variety of species in Aruba; partly and especially of *Melocacti* of the *Melocacti communes* tribe, peculiar to the Northern Antilles, and which treatise will be illustrated by two plates.—Mr. Jan de Vries made a communication concerning Cartesian confocal ovals in connection with a hyperboloid of one surface.—Prof. Rauwenhoff communicated the results of investigations, made by Dr. H. F. Jonkman at Utrecht, into the embryogeny of Angiopteris and Marattia.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Island of Dr. Moreau: H. G. Wells (Heinemann).—A Manual of Forestry: Prof. W. Schlich, Vol. 1, 2nd edition (Bradbury).—Die Vegetation der Erde. I. Grundzüge der Pflanzenverbreitung auf der Iberischen Halbinsel: M. Willkomm (Leipzig, Engelmann).—Monographie der Gattung Euphrasia: Dr. R. v. Wettstein (Leipzig, Engelmann).—A Handbook to the Birds of Great Britain: Dr. R. B. Sharpe, Vol. 3 (Allen).—Röntgen Photographs: Profs. Reid and Kuenen (Dundee, Valentine).—Leçons de Géographie Physique: Prof. A. de Lapparent (Paris, Masson).

Pamphlets.—Summary Report of the Geological Survey Department for the Year 1895 (Ottawa).—A Laboratory Note-Book of Elementary Practical Physics: L. R. Wilberforce and T. C. Fitzpatrick. I. Mechanics and Hydrostatics (Cambridge University Press).—Kepler's Lehre von der Gravitation; Dr. E. Goldbeck (Halle a/s., Niemeyer).—Flora of West Virginia: C. F. Millsuaugh and L. W. Nuttall (Chicago).—The Classification of the Chemical Elements: Prof. O. Masson (Melville).—The Jack Rabbits of the U.S.: Dr. T. S. Palmer (Washington).

Serials.—Fortnightly Review, April (Chapman).—Scribner's Magazine, April (Low).—Geological Magazine, April (Dulau).—Imperial University College of Agriculture, Bulletin Vol. ii. No. 5 (Tōkyō).—Reliquary and Illustrated Archæologist, April (Bemrose).—Journal of the Royal Agricultural Society of England, third series, Vol. vii. Part 1 (Murray).—Geographical Journal, April (Stanford).—Phonographic Quarterly Review, April (Pitman).—Zeitschrift für Physikalische Chemie, xix. Band, 3 Heft (Leipzig, Engelmann).—Annals of Scottish Natural History, April (Edinburgh, Douglas).

CONTENTS.

THURSDAY, APRIL 16, 1896.

OLD AND NEW THEORIES OF EVOLUTION

The Primary Factors of Organic Evolution. By E. D. Cope, Ph.D., Professor of Zoology and Comparative Anatomy in the University of Pennsylvania. Pp. xvi + 532. (Chicago: The Open Court Publishing Company, 1896.)

The Present Evolution of Man. By G. Archdall Reid. Pp. 370. (London: Chapman and Hall, Limited, 1896.)

PROF. COPE tells us in his preface that his work may be regarded as containing a plea on behalf of the Lamarckian view of the factors of evolution; and he believes that evidence has now been accumulated to demonstrate the doctrine, which, he says, he has defended as a working hypothesis for twenty-five years. At p. 9 of the introduction, he states, referring to one of his own papers: "By the discovery of the palæontologic succession of modifications of the articulations of the vertebrate, and especially mammalian skeleton, I first furnished an actual demonstration of the reality of the Lamarckian factor of use, or motion, as friction, impact, and strain, as an efficient cause of evolution." Such statements as these lead the reader to expect that at last we shall have something of the nature of proof of the inheritance of acquired characters, and that the difficulties and objections of those who hold Weismann's views will be fairly met and satisfactorily answered.

The work is divided into three parts, headed respectively: "The Nature of Variation," "The Causes of Variation," and "The Inheritance of Variation." The first part deals with variation, phylogeny, parallelism, and catagenesis. Very full accounts are given of the varieties that occur in some of the animals inhabiting the United States, with special reference to climatal conditions. Aridity is said to produce a blanching of colours, while moisture produces intensity. Some groups increase in size as they spread southward, others towards the north, and this is connected with the centre of the area of distribution being in the south or the north. We have also a careful description of the progressive development of several important groups as indicated by their fossil remains, with a general outline of the phylogeny of the mammalia; while the chapter on parallelism deals with the general correspondence between the course of development of the individual and of the class or order to which it belongs.

At the end of this part of the volume, which has been purely descriptive and has entirely avoided any reference to natural selection or to the broader features of variation, we find this extraordinary statement.

> "It has been proved, as it appears to me, that the variation which has resulted in evolution has not been multifarious or promiscuous, but in definite directions. It has been shown that phylogeny exhibits a progressive advance along certain main lines, instead of having been indefinite and multifarious in direction."

Of these two statements the latter is true, and has been fairly proved by the facts which have been set forth; while the former is absolutely untrue, and if the facts which this volume sets before the student do not show it to be untrue, it is only because they have been selected and set forth in such a way as to illustrate the theory that variations are in definite directions only. For example, although Dr. J. A. Allen is quoted largely to show the variations of birds in definite directions in accordance with changes of climate, nothing is said of his more important work on "The Mammals and Winter Birds of Florida," in which he has given detailed measurements showing that all the commoner species do exhibit "multifarious variations" which are also "multifarious and indefinite in direction." He shows that the total length, as well as the length of the wing, the tail, the beak, and the feet, all vary simultaneously but to a large extent independently. Further, he shows that each of the primary wing feathers, and each of the toes also vary simultaneously and to a large extent independently. Other writers have shown that in mammalia the skull and all its parts vary simultaneously; while what is known of the variation of the muscles, the nerves, the blood-vessels, the intestines, and other internal organs, show that these even exceed the external organs in the multifarious and indefinite character of their variations. All this is the common knowledge of every biologist; yet we have a great authority and experienced biological teacher, first omitting all reference to these facts, and then declaring that he has *proved* that they do not exist!

Coming now to the second division of the book, we find abundant evidence as to the changes effected in individuals by the action of various external causes, by far the larger portion being devoted to a statement of the supposed mechanical origin of the peculiar forms of the teeth and bones in the vertebrata, illustrated by the various lines of evolution made known by palæontology, and always assumed to be the result of use (or disuse) and motion. Then follows a short chapter on natural selection, which is described in the most cursory manner, almost immediately diverging to sexual selection, to which more space is given. We then have a single paragraph devoted to protective modifications of colour or form; and the author here takes the opportunity of dealing a blow at the Darwinians by first misstating their views, and then demolishing his own misstatement. He says:

> "Much is to be found of interest on this attractive subject in the writings of Wallace, Poulton, Beddard, and others. The two authors first named ascribe these colour and form characters to natural selection *as a cause.* This is, however, impossible; yet natural selection has undoubtedly been the cause of their survival."

The italics are Prof. Cope's. He then goes on:

> "The first objection to the belief that natural selection is the primary cause of organic evolution has already been stated as follows: 'A selection cannot be the cause of those alternatives from which it selects. The alternatives must be presented before the selection can commence.' But the supporters of the view that natural selection is the origin of variation, allege that it produces this result by the continual survival of minute differences which are useful, thus accumulating variation. That minute advantageous differences will secure survival no one can doubt, but it must be remembered that the variations which constitute evolution have been in a vast number of cases too minute

to be useful. But the general question is not affected by the supposition that advantageous variations may be sometimes minute. Minute or great, they have to be assumed in the argument for selection; and whether minute or great, they have a definite cause."

This very ingenious argument is well calculated to impress those readers of Prof. Cope's book who have no other sources of information that natural selection is quite a subsidiary agent in causing evolution, and that—as he says in his concluding paragraph—"the stimuli of chemical and physical forces and also molar motion, or use, or its absence, are abundantly sufficient to produce variations of all kinds in organic beings."

But they can produce this effect only on the assumption that all the modifications so produced in individuals are, partially at least, transmitted to their offspring; while those very numerous cases in which essential characters could not possibly have been produced by the causes he suggests, are entirely unnoticed. Such are all those curious structures which are only used once in a life-time; those whose only function is to alarm enemies; most of the protective forms, motions, and colours of insects, as illustrated in the stick and leaf insects, or in those which are deceptively like moss, or flowers, or the dung of birds; the poison-fangs of snakes and the stench-glands of skunks, and innumerable other examples which will occur to every naturalist. Note, too, how "*as a cause*" in the first quotation is changed immediately afterwards to "the primary cause," and the implication that we believe natural selection to be the "origin of variation" and "the cause of the alternatives from which it selects," a theory for which Prof. Cope never states his authority, and which, so far as I know, has never been even suggested, except by incompetent or careless reviewers. Strange to say we have the acknowledgment that "minute advantageous differences will secure survival," but it is followed by the proviso that "the variations which constitute evolution have been in a vast number of cases too minute to be useful." This, I suppose, means that the changes produced by external causes in the individual are too minute to be useful till transmitted and accumulated by inheritance. Whether that is so or not, no evidence whatever has been adduced; while abundant evidence exists in the works of Prof. Cope's own countrymen, and in the measurement of many hundreds of specimens of common species in this country, that normal variability is *not* minute but very large, and that this variability extends to every part and structure, and to every external and internal organ when search has been made for it. That such well-known facts as these should be entirely ignored, and the extraordinary and wholly unprovable statement made, that the variations which constitute evolution "have been in a vast number of cases too minute to be useful," seems to show that the advocates of Neo-Lamarckism feel that they have a very bad case.

In the third part, on the inheritance of variation, we expect to find some experimental facts bearing on the question at issue. But I can only find assumptions and opinions. Breeders of animals, it is said, all believe in the inheritance of the results of nutrition and exercise, and pages are given to prove such beliefs; and after describing the evolution of the American trotting-horse, Prof. Cope says:

"Viewed as phenomena, there is every appearance and indication that the changes acquired by individuals through the exercise of function have been to some degree transmitted, and have been cumulative, and that this has been one factor in the evolution of speed."

However unsatisfactory is the author's treatment of the evidence for the doctrine which forms the main subject-matter of the book, we did not expect that he would repeat the absurd argument which Lord Salisbury used at Oxford, and which has been so destructively criticised by Herbert Spencer. Yet in the chapter on "The Energy of Evolution" he gives, among the "weighty considerations" showing that natural selection cannot be the cause of the origin of new characters, the following statement:

(3) "In order that a variation of structure shall survive, it is necessary that it shall appear simultaneously in two individuals of opposite sex. But if the chance of its appearing in one individual is very small, the chance of its appearing in two individuals is very much smaller. But even this concurrence of chances would not be sufficient to secure its survival, since it would be immediately bred out by the immensely preponderant number of individuals which should not possess the variation."

Whence of course it follows, that without the Lamarckian factors to produce the right variations at the right time, natural selection is powerless, as it will have nothing to select from! It really seems incredible that after nearly forty years' discussion of evolution and natural selection such an argument as that here quoted can be set forth in a serious book by a life-long teacher and worker in the field of biology.

It is refreshing to turn to Mr. Archdall Reid's volume which, though unnecessarily diffuse, is full of original ideas and acute reasoning. The larger part of it is devoted to a discussion of the general subject of organic evolution. This is exceedingly well done, and it contains a very forcible argument against the possibility of the inheritance of acquired characters in the higher animals, derived from the facts of cell-division and specialisation in the development of the individual. This argument has not, within my knowledge, been so clearly and forcibly set forth by any other writer. There are also some very acute criticisms of the writings of Herbert Spencer and others on evolution, and great stress is laid on a rather neglected subject, the development of acquired characters during the growth of the individual, though on this point the author's views seem rather exaggerated and open to criticism. The latter portion of the book, which gives the title to the work, though original is somewhat disappointing, as it is entirely limited to evolution against disease. The author argues that this is effected solely by natural selection, and in the facts presented by the various amounts of resistance of different races to certain zymotic diseases he finds another powerful argument against the Lamarckian theory. He maintains that there is no such thing as hereditary disease, but only hereditary tendency to contract the disease. He traces most of the zymotic diseases to the unhealthy crowding that is universal in civilised communities, and he has some very strong remarks on the way in which our false civilisation is exterminating so many of the lower races. One of

these passages may be quoted as a fair example both of the author's style and of the interesting subjects he discusses.

"Are not all our efforts, whether prompted by philanthropic or religious zeal, by which we seek to protect and preserve the aboriginal races of the New World, wholly mistaken? Are they not in effect absolutely murderous? We gather them into close school-rooms and churches, where teachers and missionaries speak to them from infected lungs. We endeavour to persuade them to abandon their nomadic habits and form settled communities. We—and thereby we prove our own barbarism, the imperfection of our own civilisation—force them in climates where clothes are wholly unnecessary, and therefore a species of dirt, to wear clothes, than which a better vehicle for air and earth-borne disease cannot be well conceived. In fact we strive to bring them at one bound into that state of society which has become possible to us only at the cost of tens of millions of lives during thousands of years."

There are a few errors and perhaps some fallacies in this very interesting and well-written volume; but much may be forgiven in a book that is both original and suggestive; while in its thorough-going advocacy of the main doctrine of Weismann—the non-inheritance of acquired characters—it affords an excellent antidote to the elaborate but one-sided arguments of Prof. Cope.

Alfred R. Wallace.

THE ATOMIC THEORY AGAIN.

A New View of the Origin of Dalton's Atomic Theory: a Contribution to Chemical History, &c. By Henry E. Roscoe and Arthur Harden. Pp. 191. (London: Macmillan and Co., 1896.)

La Théorie Atomique et la Théorie Dualistique. Transformation des formules. Différences Essentielles entre les deux théories. Par E. Lenoble, Professeur de Chimie a l'Université libre de Lille. Pp. 94. (Paris: Gauthier-Villars.)

THE origin of the former of these two books is well explained in the following passage from the short introduction:

"It may seem remarkable that after the lapse of nearly a century since John Dalton first applied the atomic theory of matter to chemical phenomena, it should be possible to find anything new respecting the genesis of his ideas. And this is the more remarkable when we remember that the life and scientific labours of the great Manchester chemist have formed the subject of independent memoirs at the hands of two such able contemporaries as Charles Henry and Angus Smith. The explanation is to be found in the unlooked-for discovery, in the rooms of the Literary and Philosophical Society of Manchester, where the whole of Dalton's experimental work was carried out, of his laboratory and lecture note-books contained in a number of manuscript volumes. A careful study of these has led us to conclusions concerning the origin of the atomic theory of chemistry which differ widely from those which have been generally accepted. It has hitherto been supposed that it was the experimental discovery of the law of combination in multiple proportions which led Dalton, seeking for an explanation of this most remarkable fact, to the idea that chemical combination consists in the approximation of atoms of definite and characteristic weight, the atomic theory being thus adopted to explain the facts ascertained by chemical analysis. This prevailing view is found on examination to rest upon the authority of contemporary chemists, rather than on any explicit statement on the part of the author himself: for, strange as it may appear, no attempt to explain the genesis of his ideas is to be found in any of Dalton's published writings."

It now appears that Dalton was probably led to his theory by an attempt to apply the Newtonian doctrine of the atomic constitution of matter to the explanation of the physical properties of gases, and more especially to the case of the gases present in atmospheric air.

The evidence upon which this conclusion is based is derived partly from the newly-discovered manuscript notes of a course of lectures given by Dalton at the Royal Institution in London early in 1810. In the course of these he says that it was the consideration of the constitution of mixed elastic fluids which led him to contemplate the effect of differences of size in the particles, and thus "it became an object to determine the relative *sizes* and *weights*, together with the relative *numbers* of atoms in a given volume. This led the way to the combinations of gases, and to the *number* of atoms entering into such combinations. . . . Thus a train of investigation was laid for determining the *number* and *weight* of all chemical elementary principles which enter into any sort of combination one with another." This is a statement of Dalton's own recollection of the course of events after the lapse of seven or eight years from the time when he made his first attempts at estimating atomic weights. To this must be added the fact that the first part of his "New System of Chemical Philosophy," published in 1808, contains no account of any chemical analyses, and in the short chapter on chemical synthesis, at the end of this first part, the author speaks of the application of certain general rules which he lays down "to the chemical facts already well ascertained," the experiments conducted by himself being reserved for part ii., published two and a half years later.

On the other hand, Dr. Thomas Thomson, after a visit to Dalton in 1804, makes the very definite statement upon which chemists have generally relied. He says: "Mr. Dalton informed me that the atomic theory first occurred to him during his investigations of olefiant gas and carburetted hydrogen gas." If this was the impression carried away by an interested visitor at the time when Dalton was occupied by the earlier stages of his investigations, it is impossible to avoid the conclusion that there was some foundation for it. Dalton was occupied with the idea of atoms, their relative sizes, &c., from 1801. In the summer of 1804 he collected and analysed the gas from ponds ("System Chem. Phil.," p. 445). In 1805, he says (MS. Lecture 17, p. 16 in the book) the idea occurred to him that the sizes of the particles of elastic fluids *must* be different. We cannot, therefore, admit that the authors have fully made out their case, though it does appear probable that the idea of atomic structure was growing in Dalton's mind before he made any chemical analyses for himself; but whether it had taken the final definite shape in which it appears in the notes of the lectures at the Royal Institution, and in the "New System of Chemical Philosophy," appears to us to be still open to question.

The second book on our list is a production of wholly different type. This little volume explains how to trans-

late the language and the formula of the dualistic system into the language and formulæ current at the present day. The process is simple. It consists in writing down the dualistic formula in equivalents say HO, from this deducing *the formula of M. Berthelot*, H_2O_2, and then dividing by two the number of equivalents of all elements in the formula not comprised in a table given in the book; that is, the elements of uneven valency, and so in this case we arrive at the unitary atomic formula H_2O. This little book is not wanted in England. It might have been useful thirty years ago, but for very shame it should not have been published now, and addressed to university students by a university professor in the land of Laurent, of Gerhardt, and of Wurtz. French chemistry half a century ago was still in the front rank. For the last generation it has been practically nowhere. France owes a debt to M. Berthelot for his labours of the last forty years, first in the development of chemical synthesis, and latterly for his store of exact calorimetric determinations; but whatever gratitude the chemical part of the nation may feel for these substantial labours, the warmth of such feeling must be considerably reduced by the reflection, that chiefly to the obstinacy of M. le Ministre de l'Instruction publique, an office held for many years by the great chemist, is due the position to which French chemistry has sunk, and from which, spite of the brilliant work of a few men like le Bel, Lecocq de Boisbaudran, and Moissan, it will take the best part of another generation to rise.

OUR BOOK SHELF.

Die Mikroskopische Thierwelt des Süsswassers. Abth. I. Protozoa. Von Dr. Friedrich Blochmann. Zweite Aufl. 4to xv + 134 pp., 8 plates, 259 figs. (Hamburg: Lucas Gräfe and Sillem, 1895.)

IT is true that there are many books dealing with the microscopic fauna of fresh waters, but it is also probably the case that there are many more students and amateurs working more or less seriously at this than at any other branch of microscopic zoology. This is the first section of the second part of Kirchner and Blochmann's "Microscopic Fauna and Flora of the Fresh-waters," and the present second edition has been completely reorganised and enlarged. It treats of the Protozoa alone, and discusses them from the systematic point of view. The classification adopted is, in the main, that of Bütschli, but our author agrees with Klebs in the grouping of the Flagellata. We have general accounts of the classes and other divisions, dichotomising tables, and definitions of the genera and species, beginning with *Hyalodiscus* and *Amœba*, and working through to *Stylocometes* in the Suctorial Infusoria. *Volvox* and other forms sometimes claimed by the botanists are here included in the Flagellata, and of course the Dinoflagellata (*Peridinium* and *Ceratium* and their allies) are placed along with the Flagellata in the Mastigophora. The figures on the plates (Werner and Winter) are abundant, and are excellently drawn; a large number of them are tinted so as to show natural colours. Many of them are now very familiar, being taken from the classic works of Bütschli, Leidy, Cienkowsky, Hertwig, Greef, Stein, Klebs and Kent. The last plate gives in outline over forty selected types (the best-known forms) from the various groups of Protozoa, all magnified 100 times so as to show the relative sizes, and enable the student to realise the contrast between *Urotricha* and *Spirostomum*, between *Oikomonas* and *Pelomyxa*, and between *Actinophrys* and *Actinosphærium*. W. A. H.

Manual of Lithology: treating of the Principles of the Science, with special reference to Megascopic Analysis. By Edward H. Williams, jun. 418 pp. Six plates. (New York: Wiley and Sons. London: Chapman and Hall, 1895.)

IN general plan this book differs little from many other text-books on the same subject. The main portion is devoted to the systematic description of the different types of rocks belonging to the three groups, primary or igneous, secondary and metamorphic. By way of introduction to this part, about a hundred pages are occupied with an account of the principal rock-forming minerals and with definitions of the structures exhibited by rocks; while at the end is added a short chapter, intended for the engineer, dealing with the economic value of rocks. Throughout the book the subject is treated as far as possible from the macroscopic point of view. In the classification of the igneous rocks, a two-fold division into intrusives and extrusives is adopted. In this system the line of distinction appears to be drawn in the wrong place. The result is that types presenting very similar characters are separated widely from each other; and owing, it would seem, to the influence of the German school, this separation appears to be effected, in many cases, not so much because the rocks differ in mode of origin as because they have been kept apart by German writers who still uphold the criterion of geological age, a method of distinction, however, which we are glad to see the author clearly repudiates in the introduction.

In the description of varieties of the main types many new names, and some old ones which we hoped had become obsolete, will be met with; so that, in this part of the book, the author's own pages hardly serve to impress upon the reader the truth of the statement made in the introduction that "the tendency of modern rock analysis is toward a simplification of the subject, and the discarding of useless and misleading divisions and names."

If the book had been kept within narrower limits, we are inclined to think that it would have been more useful to the class of student for whom it is intended, viz. "the beginner in the subject who wishes a thorough knowledge in the megascopic presentation of the subject, in a fuller and more compact arrangement, than can be obtained in geological text-books." G. T. P.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Sacred Tree of Kum-Bum.

THE identification of the Kum-Bum tree with *Ligustrina amurensis* (not *amurentis*) (see p. 534) has already been communicated by M. Grigoriev to the *Bulletin du Muséum d'Histoire Naturelle* (1896, p. 33). But the Paris botanists appear to consider it doubtful.

As, however, *Ligustrina* is now merged in *Syringa*, there is a general agreement that the Kum-Bum tree belongs to that genus. We are still of opinion that the authentic leaves brought back by Mr. Rockhill belong to *S. villosa*.

Kew, April 10. W. T. THISELTON-DYER.

The Röntgen Rays and Optically Active Substances.

IN an article in NATURE (February 27) by Prof. J. J. Thomson, it is suggested that the leakage of electricity through non-conductors under the influence of the Röntgen rays is "due to a kind of electrolysis, the molecule of the non-conductor being split up, or nearly split up, by the Röntgen rays, which act the part played by the solvent in ordinary electrolytic solutions." It has occurred to me that if such ionisation really

does take place, independent evidence of it should be obtainable in the case of optically active substances by a change in their rotatory power taking place when they are exposed to the X-rays, as it is well known that the ionised molecules of active compounds are possessed of very different activity from the undissociated molecules themselves. To put this point to the test, Mr. MacGregor and I have polarimetrically examined two optically active compounds, ethylic dibenzoylglycerate and methylic acetylglycerate, interposing a Crookes' focus tube between the polarising Nicol and the column of active liquid; but although the discharge was maintained in both cases for three-quarters of an hour, there was not the slightest change in the rotation observable. To facilitate the passage of the rays, we employed a thin microscope cover-glass to close the polarimeter tube at the end nearest to the Crookes' tube, and that the rays were actually traversing the column of active liquid was demonstrated by obtaining a photographic effect at the other extremity of the tube, whilst the efficiency of the Crookes' tube was further proved by the favourite test of the skeletal photograph of a hand, which yielded an impression of great sharpness and exhibiting a most remarkable amount of detail. It would appear, therefore, that the Röntgen rays either do not give rise to any ionisation at all, or that the concentration of the ions is so small as not to be detectable by means of a sensitive polarimeter. I have previously shown, in conjunction with Mr. Pickard (*Trans. Chem. Soc.*, 1896), that the active bodies in question exhibit what appears to be a process of ionisation when dissolved in certain organic solvents, which process is accompanied by a very conspicuous change in their rotatory power, so that they appeared to be specially adapted for testing this suggested influence of the X-rays.

Incidentally we have roughly tested the relative opacity of a number of organic compounds to these rays by spreading approximately equal thicknesses of each on a number of microscope cover-glasses, which were placed on a photographic plate enclosed in a black envelope, and then exposing them all simultaneously to a Crookes' tube placed a few inches above. Out of nearly forty organic compounds belonging to both the fatty and the aromatic series, the only ones exhibiting any marked opacity contained iodine, bromine, or chlorine, the iodine compounds being the most and the chlorine compounds the least opaque. Thus methyl iodide, ethyl bromide, ethylene iodide, ethylene bromide, monobromacetic acid, tribromacetic acid, bromobenzoic acid, and trimethylenebromide were very markedly opaque, and curiously monochloracetic acid was much more distinctly opaque than either dichlor- or trichlor-acetic acid.

Mason College, Birmingham. PERCY F. FRANKLAND.

Radiographs by Fluorescent Screens.

It may perhaps interest those who occupy themselves in photographing with Röntgen rays to know that a very effective and rapid method is obtained when proceeding as I will explain. I had a piece of scheelite or native tungstate of calcium, such as occurs in a collection of minerals, crushed to a somewhat coarse powder, and made it into an emulsion with gelatine; this was applied in a consistent and uniform layer on a piece of stiff black paper, and after this was dried the surface showed numerous crystalline, glittering particles. The right condition for fluorescing was attained, as was evident, when a Crookes' tube in action was placed behind and looked at in the dark, though the luminosity was not so strong as with a screen covered with crystals of platinocyanide of barium. The paper, thus prepared, was simply laid down on a very sensitive photographic glass plate, with its fluorescent side of course in contact with the film; on the upper surface metallic objects or the fingers were put. Applying now Newton's focus tube (which, I may add, gave me excellent results in former experiments) with an induction coil, regulated to give sparks of five to six inches, I obtained sharply-defined radiographs of keys, &c., in twenty-five seconds, and of the fingers, showing the bones and metallic objects hidden between them and the plate, in ninety seconds, distinct enough to perceive even the eye in a needle that was put in the epidermis. I also tried the fluoride of calcium mentioned by Prof. Winkelmann, of Jena; but I perceived no fluorescence, perhaps because the powder was amorphous throughout. As scheelite is a very cheap mineral, large screens with fluorescent surfaces may be constructed at a trifling expense. L. BLEEKRODE.

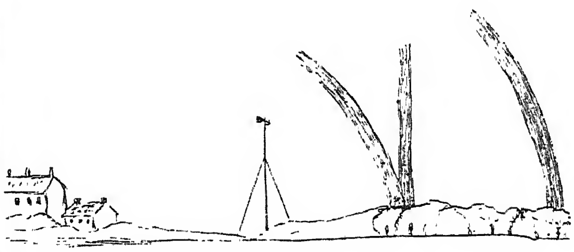
The Hague, April 6.

Perhaps some of your readers who are practising electrography are not aware that those of them who possess a potassium platino-cyanide screen can diminish their exposures to a quarter of the time now necessary. I tried the experiment yesterday, and have been more than pleased with the results. The *modus operandi* is as follows. The screen is first laid on the dark-room table, platino-cyanide uppermost. A celluloid rapid sensitive film is then placed upon it, gelatine side downwards, and in contact with platino-cyanide. Upon the top of all is placed the hand or other object to be electrographed, and in contact with the celluloid. The whole, including screen, celluloid film, and object, are then raised from the table, and a light tight cloth bag drawn over them and properly secured. This arrangement, exposed under the Crookes' tube in the usual way, gives about four times the speed attainable without the reinforcing action of the screen. The "grain" of the screen shows; but if the salt has been finely powdered before preparing it, this is no great objection. Glass-sensitive plates are of course inadmissible.

Oaklands, Chard, April 13. J. WILLIAM GIFFORD.

Abnormal Rainbows.

On March 22, about 6 p.m., a rainsquall was passing south-east of this station, and as the sun was shining clear and bright in the opposite quarter of the sky, a rainbow soon appeared. The colours were very brilliant, and a secondary bow was at once seen. From the base of the primary bow a perfectly straight vertical pillar arose of similar width, and the same colours, arranged in similar order from right to left; this was quite as distinct, and persisted quite as long as the usual rain-



Coast Guard Station.

bow, and the singular spectacle of the two rainbows with the vertical shaft attracted considerable attention, and was noticed by a large number of persons. It was described by several as the V-shaped rainbow. The sketch, made by my assistant, Mr. C. Grover, shows it as seen from the East Lodge, Rousdon, over the Coast Guard Station. C. E. PEEK.

Rousdon Observatory, Lyme Regis, Dorset.

Family Data.

A year ago circulars were printed and cards issued with a view to the formation of a collection of simple measurements on parents and children, which would be of service in testing theories of heredity. In particular, such problems as are dealt with by me in a memoir on regression, heredity, and panmixia (printed in the *Phil. Trans.* of the current year), which treats of biparental inheritance, require statistics far more numerous than have been hitherto available. The measurements are of a simple character, involving but little elaboration, and all that is required is a willing father, mother, and one or more sons or daughters.

Three thousand cards and circulars were distributed, but experience has shown that general distribution is of little practical value. The cards are readily taken, but rarely returned. The only satisfactory method is to find a willing helper who is sufficiently conscious of the importance of the problems of heredity to distribute and collect himself ten or twelve data cards.

Up to the present I have obtained measurements on about 700 families. I am most anxious to reach at least 1000. May I make an appeal through NATURE for such helpers? I am prepared to send full directions and any number of cards to any of your readers who are willing to help. All I would ask is that

they do not merely give the cards away, but themselves collect them and forward to me, as my experience has so fully demonstrated that not 5 per cent. of the recipients will take the trouble of returning them directly to me.

A collection of 1000 family measurements would be of immense value for testing various problems in heredity, and, if it be formed, I shall be only too glad that it should be ultimately deposited where it would be available for all future students of heredity.

It is, perhaps, needless to remark that the measurements required are of normal and not pathological characteristics, and no name except that of the recorder (in case of there being need of reference) is required.

All communications should be addressed to me at University College, London. KARL PEARSON.

University College, London, April 10.

The Retinal Circulation.

THE phenomenon of the retinal circulation, referred to in Mr. James W. Barrett's letter in NATURE of April 2, was, I believe, first described by Dr. Robert Waring Darwin in 1786. He writes:—"By being accustomed to observe such small sensations in the eye, it is easy to see the circulation of the blood in this organ." . . . "It is sometimes necessary to rub the eyes with a certain degree of force after they are closed, and to hold the breath rather longer than is agreeable, which by accumulating more blood in the eye, facilitates the experiment." He further states that it depends on the state of health, is most distinct when the eye is fatigued, and is best seen by looking at the sky, shading the eyes with the hand.

I have myself seen it often when a boy under much the same conditions as your correspondent, viz. lying on my back looking up at the blue sky after severe exercise.

But about fifteen years ago I discovered a method of observing it far more perfectly. While calibrating a somewhat powerful spectroscope by measuring the Fraunhofer lines with a very narrow slit and direct sunlight, I noticed that when the region between G and H occupied the field of view, the retinal circulation showed so plainly as to inconvenience me. On slightly altering the focus, so as to get rid of the lines, I could see not only the corpuscles, but the walls of the capillaries themselves with great distinctness, especially when the eye began to be fatigued. With a sufficiently narrow slit the corpuscles were visible against the other parts of the spectrum, even the red, but they appeared as mere specks, and the outlines of the vessels could no longer be discerned. Judging from this that violet light was more important than a narrow slit, I tried last year the effect of various coloured media. Of these the most successful was ammonio-sulphate of copper. A six-ounce flask, filled with a solution of this substance, held close to the eye about a yard from an arc-lamp, enabled me to see the retinal circulation and some of the vessels, but not nearly so distinctly as with the violet light of the pure spectrum. GEORGE J. BURCH.

Oxford.

JUPITER AND HIS PERIOD OF ROTATION.

A QUESTION which has recently been attracting considerable interest with regard to the greatest of our planets, Jupiter, relates to the determination of the time of rotation deduced from observations of markings on the visible surface of this planet's disc. The difficulty to be contended with here is that the appearance of the markings on the disc is always changing, and further great changes, even in short intervals of time, are noticeable. The chief characteristic features of the disc are the dark belts situated on each side of the equator, resembling to some extent the two belts of trade winds on the earth, which lie on either side of the belt of equatorial calms and rains. More minute scrutiny reveals to us other belts which are sometimes seen in considerable numbers, while their individual structure is by no means simple. These details are for the most part only temporary, and so quickly do changes take place, that the surface of the planet seldom, if ever, appears the same two nights together. Often spots are observed among these belts, which are generally of a more distinct nature than the usual markings; these are for the most part dark, but in some cases they are bright, round, and small, resembling the satellites as they travel across the primary's disc.

The extreme lack of constancy in the positions and forms of all the surface-markings has long ago taught us to cast aside the idea that we are looking at the surface of a rigid body. What we really see is the dense vapour and cloudlike formations between us and the real surface, encircling the whole planet from pole to pole, and always in a state of turmoil. This and other reasons have given us sufficient evidence to form some idea of the temperature of the planet itself, and it is now thought that the internal temperature is considerable, and probably sufficient to render the planet capable of shining to a small extent by its own light.

In consequence of the proper motion of several spots observed on Jupiter's surface and the primitive state of his atmosphere, the planet is said to resemble the sun to some extent. On account of these many points of similarity, Zöllner was led to believe that perhaps a similar law of rotation might here be in vogue which had been proved to hold good in the case of the sun by observations of spots on his surface. Lohse also, some time afterwards, after a minute discussion of all the available evidence, came to a similar conclusion, namely, that Jupiter in the region of his equator rotated quicker than in regions some distance from it.

Now this question is by no means so easy to settle as may seem at first sight. In the first place, in the cases of both the sun and this planet, the spots that are generally visible are confined to two belts north and south of the equator, while the equator and the poles are, for the most part, devoid of all such markings.

In the case of the sun, however, one need not necessarily be restricted to spot observation to determine the time of rotation near the poles, for we possess a very simple means of solving this problem by the application of Doppler's principle. The sun's limb on the east and west sides will be rotating towards and away from the observer, and an examination with the spectroscope of these regions will show us, by measuring the displacement of the lines in the spectrum from their normal positions, the velocities in the two directions. Curiously enough, both Crew and Dunér made investigations on this principle, and the results obtained were by no means the same, but, on the contrary, apparently antagonistic. The former, who observed the photosphere, found that for all latitudes the time of rotation was the same, while the latter, who examined the spots spectroscopically, obtained a decrease in the velocity as their distance from the equator increased. To explain these apparently contradictory results, Brester suggested that it seemed probable that Dunér observed the spectral lines of gases situated inside the photosphere, while Crew's observations were restricted in all probability to gases in those atmospheric layers which lie above the photosphere.

As yet no such observations near the poles of Jupiter have been attempted, although, as will be seen further on, this application of Doppler's principle has been employed for the region near the equator. Fortunately, however, in the year 1892 (October 10) a short dusky streak, oblong in shape, was observed by Stanley Williams near the north limb, extending nearly to north latitude 85°. Other similar streaks have been subsequently noticed, and frequent determinations of the times of mid-transit have been made. By good fortune the observers at the Lick Observatory had secured at the same time some good photographs of the planet, the surface-markings of which, on the negative, were sufficiently distinct for measurement.

A comparison of the times of rotation deduced from both the visual and photographic records seemed to give very satisfactory results, the mean periods differing only

by two seconds. The mean result for the surface material of Jupiter between latitudes 40° to 85° north gave 9h. 55m. 38·9s. ± 1·20s., this being the length of a sidereal rotation expressed in mean solar time. Observations of some dark, well-defined spots in 1891 gave as a value for the period of rotation 9h. 55m. 38·5s., while Denning found (1894–5) the value 9h. 55m. 39·0s., still closer to that given above.

It will be noticed that up to the present the observations of Stanley Williams do not corroborate a reduction in the rate of rotation in higher latitudes, as would be expected from Lohse's discussion. The observations of the two may, however, be harmonised to some extent if, as before, one supposes that they observed markings at different levels in the atmosphere of the planet. If this were so, then very probably Stanley Williams generally watched those markings in the higher regions, while the spots observed by Lohse were situated at a far deeper level, and in which perhaps were strong currents.

A spectroscopic investigation of great interest is that due to Dr. Belopolsky, who undertook the determination of the velocity of a point in the equatorial region of Jupiter. The method of procedure was as follows. He assumed that the equatorial region of this planet made one rotation every 9h. 50m.; knowing the angular diameter of the disc from measures made with the micrometer, he then calculated the velocity of a point on the equator, the resulting velocities being 12 and 13 kilometres per second, according to the special value of the diameter used. The second part of the work consisted in observing the east and west limbs of the planet spectroscopically, using the principle of Doppler to find out the displacement of the lines due to the velocities in the line of sight. The value he obtained was 11·4 kilometres per second, a number smaller than that which would apparently be expected. The great difference between the observed and computed velocity may be due to errors of observation, but its magnitude calls for another explanation. Belopolsky himself prefers to account for this difference by regarding it as a result of refraction, an assumption which is quite permissible, as Schmidt has shown in his theory of the sun.

Perhaps the best idea of the drift of the Jovian surface can be gathered from a summary of the determinations of the length of the period made from surface-markings at different Jovian latitudes. This table we owe to Mr. Stanley Williams, and it appeared in a previous number of Nature (vol. liii. p. 376). It will be noticed that the nine zones represent practically nine distinct currents in the planet's atmosphere, their boundaries being described as sharply defined. These currents completely encircle the planet, and have an east and west direction; very little indications of motion towards the poles having been noticed.

Zone.	Lat.	Period: In time. h. m. s.	Period: In terms of equatorial period.
I.	+85° to +28°	9 55 37·5	1·0089
II.	+28 ,, +24	9 54 30	1·0071
		9 56 30	1·0104
III.	+24 ,, +20	9 48 0	0·9973
		9 49 30	
IV.	+20 ,, +10	9 55 33·9	1·0089
V.	+10 ,, −12	9 50 20	1·0000
VI.	−12 ,, −18	9 55 40	1·0090
VII.	−14 ,, −28	9 55 40	1·0090
VIII.	−18 ,, −37	9 55 18·1	1·0084
IX.	−37 ,, −55	9 55 5	1·0081

Curiously enough, the zone numbered VII., which represents the red-spot zone, has not an equivalent in the northern hemisphere, that numbered III. having a much quicker drift.

Apropos of this red spot zone, we may mention that Mr. Stanley Williams expresses the opinion that the mysterious red spot acts in the same way as, and has some analogy to, an island in a river (*Knowledge*, April). The spot lies between the south equatorial belt and the south temperate belt, and as the white material between these two belts drifts past the red spot with a velocity of sixteen miles per hour, it is obliged to force a passage round the spot. Most of this white material passes to the north side of the spot, making a depression in the south equatorial belt; but some of it finds a way through a very narrow channel on the south side. There is less resistance to the passage of the material on the north side of the spot, probably for the reason that the surface is most plastic in the equatorial regions. As the channels on the north and south sides of the red spot are together narrower than the main channel, there is a heaping up of white material on the following side of the spot and in the channels, and this seems to possibly explain the bright annulus which is frequently seen encircling the red spot. The union of the two currents produces a commotion on the preceding side of the spot, giving rise to the hazy patch which is usually visible in that position. As a working hypothesis, the idea seems likely to be of use in suggesting observations, but it is admittedly difficult to conceive how such an effective obstacle as the red spot can drift about in the way it has done.

The latest observations regarding Jupiter's surface thus show us that the whole disc of vapour that we see is in a state of slow circulation in currents more or less parallel to the equator. The rifts that appear to traverse the disc in the north and south direction may be the effects of a slow circulation in this direction.

The east and west currents do not then necessarily increase their rate of rotation the nearer the equator is approached; but there may be zones of quicker rotation, followed by zones of slower rotation before the equator be reached. It will thus be seen that a very accurate value of the period of rotation of Jupiter is difficult to determine, since the several drifts are in relative motion one with another.

W. J. S. L.

THE LIFE OF JOSEPH WOLF.[1]

It seems now to be rather in fashion to write lives of persons still in existence. In some cases, such as the present, there is little to be said against this practice; in others, it may be open to very serious objections. But when the biography of a living person is given to us by an intimate personal acquaintance, we have, at any rate, one advantage: it may be assumed that the narrative has been more or less supervised by the person to whom it relates, and that the facts and incidents stated are generally correct. Such, we know, is not always the case with biographies of departed heroes.

Joseph Wolf, well known to all zoologists as the "Prince of Animal Painters," and one whom savants and artists alike agree to class as "absolutely unrivalled" in his special department, was the son of a German farmer, or what was formerly called in the south of England a "yeoman," farming his own land at the little village of Möerz, between Trèves and Coblentz. Born in 1820, Wolf was sent to the village school at Metternich, where his observant habits and "superior skill in drawing maps" told favourably with the master. But to his fellow-scholars a boy who "refrained from bird-nesting on principle," and would fight any of them in defence of a nest of young birds, was somewhat of a puzzle. Here, however, Wolf had many opportunities, both during his school-days and in the course of the initiation into farm-life which followed, of studying nature. A fine wild country was around him, where beasts and birds were abundant, and he soon taught himself to observe them,

[1] "The Life of Joseph Wolf, Animal Painter." By A. H. Palmer. Illustrated. Pp. xviii + 328. (London: Longmans, 1895.)

to collect them, to capture them as models, and to draw their pictures. Notwithstanding these facilities, which, however, could only be enjoyed at off-times, the monotonous drudgery of farming became at length unbearable to the nascent artist, and he at length secured his father's consent to desert the plough, and to become an apprentice to the brothers Becker, a firm of lithographers at Coblentz. At the age of sixteen, therefore, Wolf managed to struggle out of agriculture into a profession which had, at all events, an artistic character about it, and a good knowledge of which must have been of paramount value to him in after-life.

Fig. 1.—A Family Group of the Eastern Red-footed Hobby.

His apprenticeship being over, Wolf's second step in life was still more decidedly in advance. As he passed through Frankfort in search of work, his sketch-book at once attracted the notice of Rüppell, the distinguished traveller and naturalist, to whom he had been advised to show it. Rüppell sent him on to Kaup, the director of the museum at Darmstadt, where the young artist ultimately settled. At the same time, Rüppell engaged Wolf to prepare the plates for his "Systematische Uebersicht der Vogel Nord-Ost-Afrikas," upon which he was then engaged. The fifty figures of this volume, published in 1845, were the first lithographs of this sort that Wolf ever produced. They are a little rough in execution, but no one can doubt their truthfulness and artistic merit. The receipt of this book in England quickly attracted the attention of our zoologists, who at once understood that an artist had come into existence who could figure birds in a way hitherto almost undreamt of, and very different from Spix's "Aves Brasilienses," or even the best designs of Temminck's "Planches Colorées."

On visiting Leyden shortly afterwards, Kaup showed the young artist's portfolio of sketches to Schlegel, and Schlegel, who was then engaged on his "Traité de Fauconnerie," immediately secured Wolf's services for that work, to which he contributed eleven or twelve excellent plates. But after a few years at Darmstadt, Wolf came to the conclusion that there would be a better market for his artistic talent in England, where several naturalists of the day required his services. The late G. R. Gray, of the British Museum, was then engaged on "The Genera of Birds," which Mitchell had undertaken to illustrate but could not find time to complete. On Wolf's arrival in London, Gray at once set him to work on the plates of this folio work, in the Insect Room at the British Museum. The *Proceedings* and *Transactions* of the Zoological Society were, at this period, also much in want of a good artist for their better illustration. For the *Proceedings*, commencing in 1848, Wolf drew figures of a large number of mammals and birds, of which we have a list given to us in the appendix to the present work. Wolf continued to supply the illustrations of mammals and birds required for the *Proceedings*, and the greater number of those of birds wanted for *The Ibis* for about twenty years. After this our artist grew rather tired of the minute and technical details required for scientific bird-structure, and it became difficult to persuade him to undertake such subjects except on special occasions, when a new parrot was discovered, or a rare antelope brought home from Africa, of which the artist was assured that no one else could make a proper picture.

Among Wolf's drawings in *The Ibis* will be found some of the very best examples of his excellent handicraft. Hawks and falcons were always favourite subjects of his pencil, and the family group of the Eastern Red-footed Hobby (*Erythropus amurensis*), (Fig. 1.) which we are enabled to reproduce here through the favour of the publishers of the present work, is one of the prettiest of them. Not less attractive is the elegant figure of the Guatemalan Swift clinging to its rocky home (p. 8), while its pendent nests and flying companions are shown in the background. Mammals have also been always equally within the range of Wolf's able pencil, and not even Mr. Stacy Marks

himself can surpass Wolf in the introduction of feeling and humour into pictures of mammal-life.

Although after deserting scientific work Wolf was hardly the less active, and executed a large number of pictures, both in oil and in water-colours, these products of his brain and pencil are not, perhaps, so well known as his earlier work. Wolf was not elected a Royal Academician, as he certainly ought to have been, and very seldom exhibited pictures in the galleries of Burlington House. His splendid efforts are mostly hid away in the palaces and country mansions of certain great patrons, who were always ready to give him full employment. Such mansions as Lilford Hall, Colebrooke, and Guisachan, must be visited by those who wish to examine Wolf's paintings of this class. But, after all, we agree with the biographer that oil is not the material in which Wolf most excels, although it may be as an oil-painter that he prefers to be known. The best of his productions are in water-colour, and in charcoal and chalk. Such, at least, is the opinion of those who regard his work from a scientific point of view.

Before concluding this notice, we cannot avoid alluding to the way in which Wolf's scientific work has been plagiarised in Germany. On turning to the last page of the present volume, the "Royal Natural History" will be found given in the list of the most recent works which Wolf's genius has served to illustrate. Wolf's pictures, however, have arrived here in this instance by a curious route. Originally prepared for the *Proceedings* of the Zoological Society and other works, they were copied by the artist employed on Brehm's "Thierleben." Not only was this done, but in some cases Wolf's initials were removed and those of the copier ("G. M.") inserted in their place. The blocks thus altered for Brehm's "Thierleben" were subsequently purchased by Messrs. Warne and Co. for use in the "Royal Natural History," and have been so employed without the slightest acknowledgment that the designs were originally the products of Wolf's pencil. To prove this, we have only to compare the figure of the "Variegated Spider-monkey," in the "Royal Natural History" (vol. i. p. 64), with the original figure of Wolf in the *Proceedings* of the Zoological Society for 1867 (plate xlvii.). It will be seen that the former figure is initialled "G. M.," but the latter "J. W."

We will now only add an anecdote of Wolf, extracted from Mr. J. G. Millais's recently published "Breath from the Veldt." Mr. Millais, who appears to be as great an admirer of Wolf as his father is known to be, tells us that one day, some years ago, Wolf was busy on one of the superb panels which grace the walls of the late Lord Tweedmouth's Highland residence, Guisachan. Landseer, who was staying at the same house, and who, it should be remarked, was a firm believer in the pre-existence of man in other forms, came up behind Wolf, who was hard at work, and stood gazing at his picture for some time without making any remark. At last Wolf got a bit nervous, and fidgeted about. Then turning round to Landseer, on whom he was afraid the picture had created an unfavourable impression: "Well, Landseer," he said, "you might say something: I'm afraid you don't like it." "Well, not exactly that," was the dry reply; "for I was just thinking that before you were a man, Wolf, you must have been an osprey" (the bird at which the artist was working).

CHARLES CHAMBERS, F.R.S.

We have already briefly announced the death of Mr. Charles Chambers, who for thirty years has directed the Colàba Observatory of Bombay, and who, by his zeal and ability, has materially increased its reputation, and worthily upheld the cause of science in the East. Mr. Chambers received his practical and scientific training under the late Prof. Balfour Stewart, at Kew; and when, in 1866, he was appointed Superintendent of the Bombay Observatory, the fortunes of that institution appear to have been at a low ebb, and its continued maintenance by the Indian Government open to question. Mr. Chambers's appointment was at first of a temporary character, and his office the thankless one of discreetly covering the shortcomings of his predecessors, and of making the results of their observations available for scientific use. The difficulties which he had to overcome are hinted at in some of his numerous papers, which have appeared as appendices to the volumes issued from the Bombay Observatory, or in the publications of the Royal Society. For instance, in his discussion on the meteorology of the Bombay Presidency, it is mentioned that the whole of the original manuscript registers prior to the year 1847 (the observatory was founded in 1841) had disappeared, that it was doubtful, in some of the printed records, whether the time was referred to the Bombay or the Göttingen Meridian; while other evidences of looseness hindered the preparation, or necessitated the rejection of his predecessors' work.

The magnetic results appear to have been in a more satisfactory condition, and very soon after his appointment he was able to report the probability of their turning out trustworthy and valuable. With the mass of accumulated arrears Mr. Chambers grappled manfully, and in the *Philosophical Transactions* for 1869, the Bombay observations from 1859–1865 are employed to discuss the solar variation of magnetic declination at that station. The energy displayed by Mr. Chambers, and the favourable position of the observatory, intermediate in longitude between Kew and Nertchinsk, induced the Scientific Committee, consulted by the Indian authorities, at the head of whom was Sir Bartle Frere, to continue the grant to the observatory, and to supply it with new instruments of the Kew pattern. Some delay appears to have occurred in sending out these instruments from England, a delay which permitted Mr. Chambers to organise his staff and reduce his arrears.

Trained in the school of Sabine and Stewart, Mr. Chambers's earliest investigations had reference to the possibility of referring the disturbances of terrestrial magnetism to the sun, considered as a magnet with its axis perpendicular to the plane of the ecliptic. The conclusion at which he arrived was that no effect of the sun's action as a magnet is sensible at the earth. This decision, at the time, received the approval of the late President of the Royal Society, and subsequent and more elaborate investigations have tended to confirm the conclusion. This tendency to trace the magnetism of the earth to the sun, induced Mr. Chambers later to investigate, from long series of observations, the solar and lunar variations of the three magnetic elements observed at Bombay, and likewise the effect of sun-spot on terrestrial phenomena. It is not easy to do full justice to the long series of varied researches which have come from the Bombay Observatory under his able direction, or to the heavy loss which that institution sustains in his removal.

Not the least of his services to science is to enable his successor to continue the observatory under more efficient conditions than he himself found, and with a reputation considerably enhanced by his devotion.

NOTES.

A MEETING for discussion will be held at the Royal Society next Thursday; the subject, "Colour Photography," will be introduced by Prof. Lippmann.

A MEMORIAL has been projected in Germany to the late Prof. Hermann Hellriegel, of Bernburg, who died in September last. It is proposed to erect a monument in the churchyard at

Bernburg, where the remains of the distinguished investigator are interred. An appeal for contributions has been issued, and a small Committee, consisting of the President and Secretary of the Bernburg Agricultural Society and Dr. Wilfarth, Hellriegel's colleague in his researches, has been formed to carry out the details. Contributions from this country may be sent to Sir Henry Gilbert, F.R.S., Harpenden, St. Albans.

At a quarterly meeting of the Council of the Royal College of Surgeons of England on Thursday, April 9, the Jacksonian prize for the year 1895 (open only to Fellows or members) was awarded to Dr. A. A. Kanthack, of St. Bartholomew's Hospital, the subject of the essay being "Tetanus." The Walker prize, for the best work in advancing the knowledge of the pathology and therapeutics of cancer, done either partially or wholly within the five years preceding the year in which the prize is granted, has been awarded to Mr. Harold J. Stiles, of Edinburgh University. The prize consists of a gift of £100—except on this, the first occasion, when it is only £60—and a document declaratory of the award. It is open to foreigners as well as to British subjects, and the Committee are not restricted in any way as to the selection of persons qualified to receive the prize, with the exception that members of the Council are not eligible.

The following aids to scientific research are announced in the *British Medical Journal*:—M. Renier has bequeathed to the Belgian Treasury the sum of two million francs (£80,000), to be applied to the foundation of a medical institute to be called the "Institut Rommelaere."—A sum of 5,000 roubles (£500) has been granted to the St. Petersburg Medical Academy for the purposes of experiments with the X-rays. A Committee, consisting of Profs. Jegoroff (Rector of the Academy), Tavnezki, Bechtereff, and Ratimorn, has also been appointed to consider the question of the application of Röntgen's discovery to practical medicine.—A new prize has just been added to the long list of those awarded by the Paris Academy of Medicine. The prize is of the value of 24,000 francs (£960), the proceeds of a capital sum of 800,000 francs (£32,000) bequeathed by Mdme. Audiffred for the purpose. It is to be called the "François-Joseph Audiffred Prize," and is to be awarded to any person, of whatever nationality and of whatever profession, who shall within twenty-five years from January 28, 1896, discover a remedy, curative or preventive, recognised by the Academy as efficacious and specific for tuberculosis. In the meantime, the interest accruing from the bequest is to belong to the Academy, and can be applied in any way which that body may think proper.

We regret to notice the deaths of Prof. F. R. Fava, Professor of Civil Engineering at the Columbian University; Mr. John Gundlach, known for his works on the fauna of Cuba; Admiral Carlo Alberto Racchia, Vice-President of the Società Geografica Italiana; and Baron Negri, first President of the same Society.

The *Journal of Botany* for April contains a short biographical sketch of the late Mr. T. H. Buffham, who died on February 9, at the age of fifty-six. He was one of the new English botanists who have devoted themselves to the study of Algæ (especially seaweeds), and had made many interesting observations on their mode of reproduction, which have been published in the botanical journals.

The death is announced in the *Times* of Dr. William Sharp, F.R.S., at the advanced age of ninety-one. He began the study of medicine in 1821, and in 1827 he obtained the diploma of the Royal College of Surgeons. Going over to Paris he attended the University lectures at the Sorbonne, listening to Gay Lussac on physics and Thenard on chemistry. He also attended Orfila's lectures at the School of Medicine. In 1828 Dr. Sharp returned to England, and settled in Bradford; in the ensuing year he was elected surgeon to the infirmary, and in 1837 senior surgeon. In 1843 he resigned his practice in Bradford, and after four years spent in Hull, where he gave winter courses of lectures on chemistry, he went to Rugby in 1847. As early as 1839 Dr. Sharp spoke in favour of local museums. A Philosophical Society was established in Bradford, of which he was elected first President; and his paper on "Local Museums," read before the British Association, led to the establishment of such museums in most provincial towns. He was elected a Fellow of the Royal Society in 1840. It was in consequence of his urgent recommendation that the teaching of physical science was introduced by Dr. Tait into Rugby School, and Dr. Sharp himself became the first "Reader in Natural Philosophy" in 1849 and 1850. From the latter year onwards he gave all his thought and attention to the improvement of the medical treatment of the sick. He made searching investigations into all the systems and schools of medicine, and embodied the results of his studies in a series of "Essays on Medicine," which appeared at irregular intervals, and reached a total of upwards of sixty treatises before his death.

The Council of the Society of Arts offer the Fothergill Prize of £25 and a silver medal for a paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire." The paper should consist of about eight thousand words, and be written with a view to being read and discussed at an ordinary meeting of the Society. Papers submitted for the prize must be sent to the Secretary on or before October 1, 1896. Each paper must be type-written, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto.

Our American correspondent writes, under date April 3:—"Prof. Ogden N. Rood, of Columbia College, has reflected the X-rays from platinum, the amount of reflection being estimated at 1/1260th part of the incident rays.

"The schooner-yacht *Coronet*, which left Brooklyn on December 5, with an equipment for observing the total eclipse of August 9, at Japan, arrived at San Francisco after a successful voyage of 117 days around Cape Horn. Captain James, the owner, and Prof. Todd and his assistants of the Amherst College observation party, will immediately cross the continent by rail, and the yacht will proceed on her voyage in a few days.

"The Local Committee of the fourth Buffalo meeting of the American Association for the Advancement of Science has been organised, and all the Sub-committees appointed. Mayor Jewett is President, and E. P. Dorr is Local Secretary. The Association will meet on August 24. The city of Buffalo will also entertain this year the National Educational Association, the League of Press Clubs, and the American Public Health Association.

"The intense cold weather and numerous severe storms of the past few weeks call for special mention. As late as March 24, a man was frozen to death in central New York. On the 28th the most severe snow-storm of the season, and one of the worst ever known, was reported from Quebec. Even after the month of April began, one of the most severe blizzards on record swept over the north-west, with temperature near zero at some places, accompanied by a remarkable snow-fall, sufficient to blockade roads generally, and to cause snow-drifts from ten to twenty feet deep.

"Ground will be broken this month for the Polhemus Clinic, an adjunct to the Long Island College Hospital. It is the gift of Mrs. Caroline H. Polhemus, as a memorial of her

deceased husband, Henry D. Polhemus. The building will be eight stories high, 67 by 92 feet in dimension, with the top coping 116 feet above the street. The land and building cost over 300,000 dollars, and apparatus and equipment will bring the total cost up to about 500,000 dollars; being, with perhaps one exception, the largest individual contribution to one charity ever made in Brooklyn. The admirable Hoagland Bacteriological Laboratory is in immediate proximity."

WE learn from *Science* that a Bill has been passed by the Legislature of Maryland, and signed by the Governor, entitled "An Act to establish a State Geological and Economic Survey, and to make provision for the preparation and publication of reports and maps to illustrate the natural resources of the State, together with the necessary investigations preparatory thereto." 10,000 dols. annually is appropriated for carrying out the provisions of the Act, and a Commission has been established, composed of the Governor of the State, the Comptroller, the President of the Johns Hopkins University, and the President of the Maryland Agricultural College. At a meeting of the Commission, on March 25, Prof. William Bullock Clark was apppointed State Geologist. He will at once begin work in the field.

A MEETING of the Institution of Mechanical Engineers will be held on Wednesday, April 29, and Friday, May 1. The President, Mr. E. Windsor Richards, will deliver his inaugural address on Wednesday evening. The adjourned discussion will be resumed on the same evening upon the paper, "Notes on Steam Superheating," by Mr. William H. Patchell, read at the last meeting. The following papers will be read and discussed on Friday evening: "Steel Steam-Pipes and Fittings, and Benardos Arc Welding in connection therewith," by Mr. Samuel MacCarthy, of London; "Research Committee on the Value of the Steam-Jacket—Experiment on a Locomotive Engine," by Prof. T. Hudson Beare and Mr. Bryan Donkin. The anniversary dinner will take place on Thursday, April 30.

THE spring meeting of the Iron and Steel Institute of Great Britain will be held on Thursday and Friday, May 7 and 8 next, at the Institution of Civil Engineers, Westminster, under the presidency of Sir David Dale. Upon that occasion the Bessemer Gold Medal, which is awarded annually in recognition of meritorious services in advancing the science or practice of the metallurgy of iron and steel, will be presented to Dr. Hermann Wedding, of Berlin. The list of papers down for reading and discussion is a full and comprehensive one, there being no fewer than ten communications on a variety of metallurgical subjects. Prof. Roberts-Austen, C.B., will contribute a paper on the rate of diffusion of carbon in iron, whilst Mr. J. S. de Benneville, of Philadelphia, will read one on some alloys with iron carbides. The application of Mond gas to steel-making will be described by Mr. John H. Darby, and Mr. B. J. Hall will discuss the subject of hot-blast stones. The Baron von Jonstorff, of Neuberg, will read a paper on standard methods of analysis, whilst the hardening of steel will be dealt with by Mr. H. M. Howe, of Boston, and M. F. Osmond, of Paris. Mr. Perry F. Nursey will read a paper on a new process for the production of metallic bars of any section by extrusion at high temperature. The treatment of magnetic iron sand will be brought under notice by Mr. E. Metcalf Smith, of New Zealand, and the iron ores of Oxfordshire will be dealt with by Mr. E. A. Walford.

THE sixty-fourth annual meeting of the British Medical Association will be held at Carlisle on Tuesday, Wednesday, Thursday, and Friday, July 28–31. The officers are as follows:—President: Sir J. Russell Reynolds, Bart., F.R.S., President of the Royal College of Physicians. President-Elect: Dr. Henry Barnes. President of the Council: Dr. J. Ward Cousins. Treasurer: Dr. Henry T. Butlin. The scientific business of the meeting will be conducted in nine sections, of which the respective Presidents are as follows, namely:—(A) Medicine, Dr. George F. Duffey; (B) Surgery, Dr. Alexander Ogston; (C) Obstetrics and Gynæcology, Dr. J. Halliday Croom; (D) Public Medicine, Sir Joseph Ewart; (E) Psychology, Dr. J. A. Campbell; (F) Pathology and Bacteriology, Mr. Sheridan Delépine; (G) Ophthalmology, Dr. David Little; (H) Diseases of Children, Dr. James Finlayson; (I) Ethics, Dr. T. F. I'Anson. An address in Medicine will be delivered by Sir Dyce Duckworth, and one in Surgery by Dr. R. Maclaren.

AN instructive article on "The General Bearings of Magnetic Observation," contributed to the current number of *Science Progress* by Captain E. W. Creak, should be read by all who are interested in terrestrial magnetism. What the article chiefly aims at showing is the great importance of magnetic observations. As an example of the application of the same, it is remarked: "We have now heavily armed, protected steel cruisers steaming over all parts of the world with less change of deviation of the compass than the wood-built *Erebus* and *Terror* of Ross's Antarctic expedition, and this remarkable result could not have been achieved if the terrestrial magnetic observer had not done his work." Still, much more remains to be done before sufficient is known about the secular change of terrestrial magnetism to enable magnetic charts to be provided to navigators for years in advance, just as the tides can now be tabulated for his use.

THE Council of the Physical Society, in a circular issued to the members, call attention to the expense attending the publication of abstracts of physical papers, which has been so successfully undertaken by the Society for a little over a year. The proposals now submitted to the consideration of members with a view to meeting this expense are, firstly, that the annual subscription should be raised to two guineas; secondly, that existing life members should pay an annual subscription of one guinea, or an additional composition of fifteen guineas; and, lastly, that an annual guarantee fund should be raised for the next five years to cover the probable deficit. Towards this latter fund nearly £100 per annum has been already promised. It is universally admitted that these abstracts have proved an incalculable boon to physicists all over the world, and we therefore hope that the last proposal will commend itself to all, whether members or non-members, who appreciate this useful and important work.

A FINE series of photographs of flying bullets, both in free air and in different stages of penetrating through a pane of glass, have been taken in Italy by Dr. Q. Majorana Calatabiano and Dr. A. Fontana, of the Italian Artillery. The apparatus described is a modification of that employed by Prof. C. V. Boys, and these photographs might, perhaps, more correctly be described as skiagraphs, since they are shadow-pictures produced on the photographic plate by the light from an electric spark produced by the discharge of a condenser. The chief peculiarity of the present figures is that, in addition to the anterior wave produced by the advance of the aërial disturbance, they exhibit dark striæ just in front of the projectile—a result not previously observed, and which the authors account for by supposing that the sudden compression of the air causes condensation of moisture producing an opaque cloud. In support of this theory, it is stated that the experiments were performed in a moist atmosphere. This blurred appearance is very similar to that which would be produced by the sparks arising from an oscillatory discharge of the condenser, but the careful precautions adopted by the experimenters to prevent any secondary discharge negative this explanation.

In two papers which appear in English, in No. 22 of the *Communications* from the Laboratory of Physics at the University of Leyden, Dr. P. Zeeman gives the results of the measurements he has made on the absorption of electrical vibrations in electrolytes. The method employed consists in starting oscillations in a Lecher wire system by means of a Blondlot oscillator; the wires passing for a part of their length through a trough containing the electrolyte. In order to measure the energy of the vibrations at any point of the wire, the arrangement employed by Rubens, consisting of two very small Leyden jars, the outside coatings of which are connected through a bolometer, is used by the author. In a preliminary series of experiments, in which a solution of sodium chloride having a conductivity $3 \cdot 2 \times 10^{-7}$ times that of mercury was employed, it was found that, for oscillations having a wave-length in air of 6·4 metres, and for which the logarithmic decrement (the γ of Bjerknes) was 0·34, the intensity of the oscillations are reduced to $1/e$ of their initial intensity after passing through 5·7 c.m. of the solution. These results were somewhat vitiated by the fact that the deflections of the bolometer decreased as the jars were moved along the wires in the electolyte, but instead of becoming zero they gradually reach a constant value. The result given above was obtained by diminishing all the readings by this constant amount. In a subsequent series of experiments, in which the spark gap of the primary oscillator was altered, this constant deflection was practically eliminated. In this series experiments were also made, using a solution of copper sulphate having the same specific resistance as the solution of common salt, and it was found that in both cases the intensity of the vibrations was reduced to $1/e$ after passing through 5·1 c.m. of the electrolyte. Hence, the author concludes that, in dilute solutions of different electrolytes having equal conductivities, electrical vibrations of the same period are equally absorbed.

The velocity of an earthquake-wave within a short distance from the epicentre is so difficult to ascertain on account of the large error resulting from a small error in the recorded times, that all estimates with an approach to accuracy are of value. In the Brescian earthquake of November 27, 1894, good time-determinations were obtained at ten stations, all within 445 km. from the epicentre. Assuming the velocity to be uniform in all directions, Dr. M. Baratta calculates it to be 1·411 km. per second. Taking account of the nature and extent of the rock traversed by the earth-wave, he also finds the average velocity to be ·782 km. per second in alluvium, and 1·569 km. per second in the older and more coherent rocks.

A couple of teeth found at Taubach, near Weimar, are claimed by Dr. A. Nehring to be the oldest human teeth yet found in Europe (*Verhandl. Berlin Anthrop. Ges.*, 1896, p. 573). One of these is a milk molar, and the other a permanent first molar of the left lower jaw. The crown of the latter measures 11·7 by 9·9 mm., and has three outer and two inner cusps, besides minor cusps and folds; in this, and in the occurrence of grooves and holes in the outer side of crown, the tooth is remarkably like that of the chimpanzee, but not much like that of the gorilla or orang. Dr. Nehring calls attention to the fact that the first pre-molar and last molar are reduced in size in modern man as compared with early man, and he finds exactly the same in domesticated, as compared with wild, dogs. In domesticated dogs, as in civilised man, the jaw is relatively feebly developed, and there is a tendency to reduction of the last molar.

In the collection of mammals, made in connection with the recent re-survey of the boundary line between Mexico and the United States, are several which appear to be new to science. In view of the probable delay in issuing the complete report on these collections, advance sheets are being issued containing preliminary diagnoses of the new forms. In one of these sheets, just received, Dr. E. A. Mearns describes as new sub-species *Spermophilus mexicanus parvidens* (Rio Grande Spermophile) and *S. harrisi saxicolus* (Rock Spermophile). The common "Jackrabbit" of the Rio Grande, described by Audubon and Bachman, Baird, Allen, and other writers as *Lepus callotis* and *L. texianus*, is taken to represent a new species, which has been named *L. merriami*. Two new species of mouse, *Peromyscus canus* (Texas grey mouse) and *P. tornillo* (Tornillo mouse), are described, and two new sub-species, *P. texanus medius* (San Dilgo-plains mouse) and *P. t. clementis* (San Clemente mouse).

Technical bacteriology has received an interesting addition to its list of useful fermenting moulds, in the shape of a recent contribution from Dr. C. Wehmer. At the instigation of and with the assistance of Dr. Went, of Java, Dr. Wehmer has isolated and carefully studied the organism responsible for the production of the well-known Soja (Tao-Yu). So far, it appears to have every right to be regarded as a novelty, although in some respects closely allied to the *Aspergillus oryzæ* of Japanese fame. In designating this organism as *Aspergillus Wentii*, Dr. Wehmer gracefully acknowledges Dr. Went's important share in its discovery and identification. In artificial cultures it is readily distinguished from its Japanese *confrère*, as it produces a pigment approaching a light chocolate in colour, whilst the former elaborates a greenish-yellow growth. The method adopted for its collection is very simple, merely consisting in covering up boiled beans, subsequently superficially sun-dried, with the leaves of *Hibiscus tileacus*; the much-valued *Aspergillus* then invariably makes its appearance on the beans, and the usual process of manufacture is then proceeded with. Curiously no other article of food offers any attraction to the Aspergillus, beans alone serving for its capture. This method of collecting the mould exactly resembles that employed by the Chinese in their process of arrak manufacture. The original memoir is accompanied by some beautiful plates, and one of these shows very clearly the different appearance on rice-cultures of the *Aspergillus oryzæ* and the *Aspergillus Wentii* respectively.

We have received the first part of a *Handbuch der praktischen Zimmergärtnerei*, by Max Hesdörffer (Berlin: Oppenheim). It appears to be a very complete practical guide to the indoor cultivation of plants, published at a very low price (75 pf. when complete). The present part contains a chromolithograph, and a number of wood-block illustrations of utensils and of gardening processes.

The Rebman Publishing Company, Limited, have in the press for publication a serial work exemplifying the uses of the new photography in medical and surgical diagnosis, entitled "Archives of Clinical Skiagraphy," by Mr. Sydney Rowland. The first part will consist of six collotypes (10 by 12½ inches), illustrating cases in which the method has been successfully applied to elucidating obscure injuries to the knee, elbow, and other parts of the body. The first plate is a skiagram of the complete osseous system of a full-grown child—the largest subject as yet done.

A new local bi-monthly magazine—the *Halifax Naturalist*—has made its appearance, its object being to publish information concerning the natural history and archæology of the ancient parish of Halifax, and to record the doings of the Halifax Scientific Society. The first number contains a coloured geological map of Halifax, by Mr. C. E. Fox, and articles on some physiographical features of the district, by Mr. W. Simpson; the birds of the Luddenden Valley, by Mr. H. Waterford; and the flora of Halifax, by the editor, Mr. W. B. Crump. Such a magazine should awaken interest in the wild life of the parish to which it belongs, and lead to a keener and wider appreciation of the works of nature.

WE have received the meteorological *Jahrbuch* of the observatory of the Magdeburg *Journal* for the year 1894. The results are given in the same form as in the previous twelve volumes, and the work is a good sample of the way in which complete observations and means may be condensed into a compact and convenient form. The first part contains eye observations made thrice daily, and the second part contains hourly observations from self-recording instruments with facsimile traces of the sunshine recorder, and also curves of the barograph and thermograph for periods of disturbance, mostly during thunderstorms. The highest shade temperature recorded during the year was 94°·3 in July, and the lowest 0°·9, in January. The total annual rainfall amounted only to 19·4 inches, and the greatest fall in twenty-four hours was 1·6 inches.

AMONG the papers published in the March number of the *Journal* of the Royal Horticultural Society (vol. xix. part 3, 1896), are three to which attention may profitably be directed here. Mr. Francis Darwin has a paper on "Etiolation as a Phenomenon of Adaptation." Mr. A. W. Sutton contributes an account of the introduction and cultivation of the potato, illustrated by numerous figures. He has made some grafting experiments with the potato and tomato, and describes his results in his paper. As a result of introducing a tomato graft upon a potato stem, the potato roots, maintained in growth by tomato foliage, produced a crop of potatoes in the pot, while the tomato foliage above ground produced a crop of tomatoes, nourished by the potato roots in the pot. In a short paper, Dr. Maxwell Masters describes a number of substitutes for larch. He shows that there are many conifers which more or less fully realise the characteristics of an ideal substitute for larch trees.

WHEN Henri St. Claire Deville, in company with Debray, Morin, and Rousseau Bros., erected the first plant specially designed for the manufacture of aluminium, forty years ago, they did not foresee the greatness of the future of the industry they founded. A sign of the growth of the industry in the United Kingdom is the appearance of a monthly periodical, *Aluminium and Electrolysis*, which will be concerned with all matters pertaining to the manufacture and use of the metal. France and the United States have for some time led the way in aluminium manufacture, and have had their special journals, but no paper primarily devoted to the interests of aluminium has hitherto been published in the United Kingdom. The addition to the ranks of industrial journals is made at an opportune time, for, after a period of quiet, once more increased attention is being given to aluminium in Great Britain.

IT is not given to many scientific discoveries to command so much popular attention as Röntgen's discovery of the X-rays; and the demand for information on the subject has resulted in a copious supply of lectures and literature, while the desire to revel in the marvellous has been gratified by a plenitude of photographs of invisible objects, published in various forms. Messrs. Valentine and Sons have added to their series of collotype view-books a brochure containing reproductions of eight Röntgen photographs taken by Profs. E. Waymouth Reid and J. P. Kuenen at University College, Dundee. A brief description is given of the method of work, and of each photograph. Another publication on the same subject, by August Dittmar, has been published by Mr. F. Bauermeister, Glasgow. This pamphlet contains a general statement of the elementary principles which result in the production of kathode rays and Röntgen photography, illustrated with eleven text-figures and one photograph obtained by means of X-rays.

AMONGST the products of the reaction at 400°–500° of hydrobromic acid upon phosphoryl trichloride, M. Besson (*Comptes rendus*, April 11) has succeeded in isolating the missing phosphoryl chlorobromide $POClBr_2$. This is a solid substance at the ordinary temperature, melting at 30°, and distilling under normal atmospheric pressure at 165°. Its boiling-point is not fixed, however, as it slowly decomposes into the chlorobromide $POCl_2Br$ of Menschutkin and phosphoryl tribromide, a property which renders its isolation by fractional distillation difficult. Besides these two chlorobromides and the tribromide, M. Besson obtained considerable quantities of solid phosphorus pentabromide from the product of the original reaction. The formation of this substance is remarkable, as it involves the replacement of the oxygen of the phosphoryl group by bromine with elimination of water, whereas at ordinary temperatures the inverse change is known to take place with great vigour.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Mr. Owen L. Hancock; a Red and Blue Macaw (*Ara macao*) from Central America, presented by Mr. Eugene E. G. Jones; a Dusky Duck (*Anas obscura*, ♀) from North America, presented by Mr. W. H. St. Quintin; an Indian Elephant (*Elephas indicus*, ♂) from India, two Red-beaked Weaver Birds (*Quelea sanguinirostris*) from West Africa, a Java Sparrow (*Padda oryzivora*) from Java, a Rose-breasted Grosbeak (*Hedymeles ludovicianus*) from North America, a Lesser Black-backed Gull (*Larus fuscus*), British, deposited; a Caffer Cat (*Felis caffra*) from South Africa, purchased.

OUR ASTRONOMICAL COLUMN.

MIRA CETI.—For some years past it has been found that the predicted maxima of this famous variable star, based upon a period of 331 days, have been several weeks in advance of the actual maxima, and it would seem that the time has arrived when a new discussion of its light-curve should be undertaken. According to the ephemeris, the last maximum was due on December 9, but the greatest brightness did not occur until towards the end of January, as shown by the following summary of the observations (*Bull. Soc. Ast. de France*, April):—

Date.		Mag.	Date.		Mag.
Nov.	1–11	9·0	Jan.	15	3·7
	15–30	8·2		18	3·5
Dec.	1–10	7·8–7·5		20	3·2
	15–31	7·5–6·5	Feb.	1	3·2
Jan.	1	6·0		15	3·4
	7	4·8		20	3·6
	9	4·2	March	1	3·8
	10	3·8		10	4·2

According to M. Dumenil (*Comptes rendus*, March 30), the magnitude at maximum during the last twelve periods has varied between 2·5 and 4·7. This fact, in conjunction with the apparent irregularity of the light-curve, indicates that there is more than one source of variability. On the meteoritic hypothesis the variations are produced by two or more swarms of meteorites revolving round a larger central swarm, and passing through its outlying parts near periastron. On this supposition it may be possible to analyse the light-curve of Mira so as to determine the part played by the individual sources of variation, each of which may be perfectly regular.

AN EXHIBITION OF ASTRONOMICAL PHOTOGRAPHS.—An international exhibition of astronomical photography will form part of the Berlin Industrial Exhibition to be held this year, from May 1 to October 15. Herr F. S. Archenhold, who is arranging the collection, has just sent out a circular asking for contributions of photographs of astronomical instruments of historic interest, of plans and buildings of observatories, as also the reproductions of astronomical drawings and kindred subjects (such as spectra, luminous night-clouds, &c.), lantern-slides 8½/10 cm. in size, or larger, also separate heliogravures already published in the annals of observatories, may be sent in to complete the photographic collection. In all cases, where it is not especially requested that they shall be returned, photographs will be retained and preserved as a complete collection, which, together

with the models of telescopes, made especially for this purpose in the mechanical department of the Grunewald-Sternwarte, will form the foundation for an astronomical museum. It is requested that every photograph shall be furnished with the name of the observatory sending it in, also the exact particulars as to date and time of exposure, method of developing, name of object, and any thing of interest connected therewith. It would also be desirable to state on the backs of the photographs, if, and in what publication, any further particulars may be found concerning the same subject. Though the exhibition opens on May 1, any pictures, which owing to the distance of the observatory sending them, should not arrive by that date, can be received at any subsequent period. As, however, a catalogue is to be completed by July 1, it will be to the interest of exhibitors to see that their contributions arrive in Berlin on July 15 at latest. Particulars as to the number and extent of intended contributions should be sent as early as possible to Herr F. S. Archenhold, Grunewald-Sternwarte, bei Berlin.

THE SUN'S ROTATION.—Two methods have hitherto been chiefly employed to determine the period of the sun's rotation, namely, observations of sun-spots and determinations of the displacements of lines in the spectrum of the sun's limb. A third method, depending upon the movements of faculæ, has recently been utilised by W. Stratonoff (*Ast. Nach.*, 3344). His results are based upon an investigation of 400 photographs of the sun, taken during 1891–1894, and the number of daily angular movements available for discussion amounts to 1024, after rejecting those in which identifications on successive photographs were at all uncertain. All the facts which are brought together clearly indicate that faculæ in different heliographic latitudes move with different velocities, and that the rate of movement diminishes in passing from the equator towards the poles. In the zone 10°–19° the retardation amounts to 0°·37 per day as compared with the equatorial angular velocity, while in the zones 20°–29° and 30°–40° it is 0°·47 and 1°·0 respectively. The law of variation of the velocity of the faculæ with the latitude is much more complex than in the case of spots; from 0° to 8° the angular velocity is almost constant, from 9° to 16° it decreases very rapidly, between 16° and 25° it remains nearly uniform, while from 25° to 34° it again diminishes quickly. Similar results are obtained for both solar hemispheres. The faculæ appear to move more rapidly than the spots in all solar latitudes from 0° to 40°, as shown by the following mean values:—

Heliographic latitude.		Diurnal angle of rotation. Faculæ.		Spots.
° °		°		°
0–9	...	14·61	...	14·30
10–19	...	14·24	...	14·15
20–29	...	14·14	...	13·83
30–40	...	13·61	...	13·40

The spectroscopic measurements made by Dunér indicate that the photosphere rotates even more slowly than the spots, and the following comparison shows the relation of the surface rotation with that of the faculæ:—

Heliographic latitude.		Diurnal angle. Stratonoff.		Dunér.
°		°		°
0	...	14·61	...	14·14
15	...	14·24	...	13·66
30	...	13·87	...	13·06

So far as the available data permit any conclusions to be drawn, it thus appears that there are three distinct laws of rotation for what in all probability correspond to three different solar levels.

THE TSETSE FLY-DISEASE.[1]

FOR forty-six years the Tsetse fly has been notorious as a terrible scourge to live-stock, and the most formidable of impediments to colonisation in Equatorial and South Africa. First brought into prominent notice by the explorers Gordon-Cumming Oswell and Captain Vardon, it was described by Westwood[2] in 1850, under the name *Glossina morsitans*, from specimens collected by the last-named traveller. The genus, an ally of our common blood-sucking *Stomoxys*, contains six described African species, for all of which Tsetse appears now to serve as a common name.

The peculiarities of the fly and "fly-disease" have been made familiar by most other African travellers, Livingstone, Andersson, Chapman, Selous, &c. The Tsetse (Fig. 1) is a dipterous insect, of no striking appearance, grey, with darker stripes on the thorax, and a pale or yellowish abdomen furnished with two dark spots on the anterior portion of each segment; it is rather larger than the house-fly, but is narrower when at rest, the wings overlapping. The mouth-parts form a powerful, piercing and suctorial beak. Local in distribution, the fly occurs in numerous detached regions of Africa south of the Equator, its headquarters appearing to be along the Zambesi and its tributary the Chobe. "Fly-country" is hot, moist and low alluvial ground, along river-banks, covered with forest or scrub vegetation, and uninhabited save by wild animals. Within its sharply-defined limits, which may extend along one bank only of a river, the Tsetse swarms; it is extremely active, and eagerly attacks man or animals for the purpose of sucking blood. On man no effect is produced beyond temporary irritation, of which the extent has been very variously described, probably in accordance with the idiosyncrasy of the victims. Wild animals do not suffer; but domestic animals, which have entered fly-districts, are seized in the course of a few days with fever and wasting, and almost invariably die. Horses and dogs rapidly succumb, while goats, donkeys and unweaned calves are said by some travellers to be resistant; this, however, is not generally true of the two former kinds. Slight non-fatal attacks confer no immunity, but some native breeds of dogs enjoy partial protection, although a certain number of pups in each litter perish. Books of African travel are full of records of horses, teams of oxen, or herds of native cattle having been destroyed by entering fly-districts, and on one occasion a Masai army, proceeding to the attack of a neighbouring tribe, was effectually routed by having incautiously crossed fly-country.

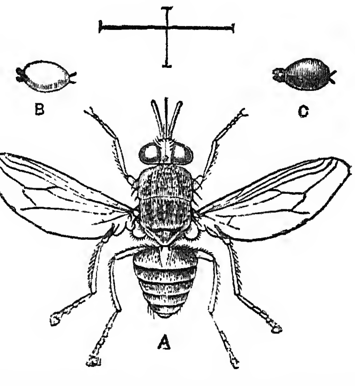


FIG. 1.—A, Tsetse fly (*Glossina* sp.), Transvaal; B, larva; and C, puparium of a Tsetse (after Bruce).

For some years the accounts of fly-disease were not seriously questioned, until in 1870 a Mr. St. Vincent Erskine[1] endeavoured to show that it was due solely to change of grass or climate, and severely criticised Livingstone's account, forgetting that the proper course lay in attempting to reconcile the apparent discordance between his own and other observations. Since then Hartmann, Marno, Falkenstein and other travellers who found either the fly present and disease absent (as on the Loango coast), or the reverse, have further discredited the earlier statements, and so eminent a dipterologist as Van der Wulp,[2] in summarising the evidence, has concluded that the Tsetse is not injurious, or that its ill-effects are exaggerated. Nevertheless travellers, especially in the Zambesi district, whilst adding nothing to our knowledge, have constantly reaffirmed the connection between the fly and the disease.

One or two naturalists have indeed hit the truth, and among them Schoch, who in an ably-reasoned little paper[3] concluded that the facts pointed, not to the action of a specific fly-virus, as was originally supposed, but to the transmission of a bacterial

[1] "Preliminary Report on the Tsetse Fly-Disease, or Nagana, in Zululand." By Surgeon-Major David Bruce, A.M.S. (Bennett and Davis, Field Street, Durban.)
[2] *Proc. Zool. Soc. Lond.*, 1850, pp. 258–270.

[1] Paper read before the Nat. Hist. Assoc. of Natal, reported in *The Entomologist*, v. p. 217.
[2] *Tijdschr. Ent.*, 1884, pp. 143–150.
[3] *Mitth. Schweiz. ent. Ges.*, 1884, pp. 685–686.

poison-matter. It will be seen that this conclusion is substantially correct.

Mysterious as has been the connection between the Tsetse and the animal-disease endemic in its haunts, there has been never any reason to doubt that a properly-conducted investigation would throw much light on the subject. At last, on behalf of the Natal Government, such a research is being made by Surgeon-Major Bruce, and the results of the first three months' work are just published. They are of great interest, and are full of promise that our knowledge of this disorder will be placed at least on a level with that of kindred diseases.

Dr. Bruce, in a somewhat brief recapitulation of the characteristics and habits of the fly, adds one important new fact, of which he appears scarcely to recognise the significance. The fly investigated, which is not necessarily Westwood's species, is viviparous, giving birth to an adult larva (Fig. 1, B), which creeps about actively in search of a hiding-place, where, in the course of a few hours, it changes by the usual skin-hardening to a jet-black puparium (Fig. 1, C). Hitherto the accounts of Bradshaw and Chapman have asserted, on native authority, that the maggot lives in buffalo-droppings, and a statement of Edwards, quoted by Castelnau,[1] that the Bushmen declared and demonstrated the Tsetse to be viviparous, has gone almost unnoticed.

This fresh observation must be accepted with some reserve, as the fly has not yet been bred from the puparium. Assuming it to be correct, it is of two-fold interest; the mode of reproduction is substantially that which exists in the Pupipara, though, to judge from Dr. Bruce's account and rough figures, the newly-extruded Tsetse-larva, though equally mature, is somewhat less abnormal than that, for instance, of *Melophagus*.[2] A transitional series from oviparous forms has been described in Muscidae by Portschinsky,[3] and viviparous Oestridae are well known to occur. Nevertheless, this peculiarity of *Glossina*, which could not have been prognosticated on systematic grounds, sufficiently demonstrates the unsoundness of separating the Pupipara from Muscidae on account of developmental differences.

Moreover it shows that the Tsetse, unlike most blood-sucking insects, such as the flea or mosquito, is absolutely dependent for its continued existence upon the food taken in the imaginal state, and, unless it is capable of feeding upon other matters than blood, which, though unlikely, should not be disregarded in the inquiry, its life is bound up with that of the indigenous mammalia. And this both confirms and explains the observation made by Livingstone, Selous and others, that it is constantly associated with large game, such as the buffalo, and ceases to frequent districts from which they retreat.

Fly-disease or Nagana (a Zulu term, aptly signifying to be low or depressed in spirits) is due, according to Dr. Bruce, to the presence in the blood of a flagellated infusorian. This hæmatozoon (Fig. 2) is of elongate form, about 10–20 μ long by 2 μ wide, furnished with a membrane or "fin" running along one side of the body, and a flagellum at one end.

It is intimately allied to, if not actually identical with, *Trypanosoma evansi*, the hæmatozoon of "Horse Surra." At present Dr. Lingard, the leading authority on that Indian animal-disease, hesitates to regard the two complaints as the same, because Surra does not attack cattle. But when it is recollected that Nagana pursues a much slower course in cattle than in horses, and that wild game are immune to it, just as African sheep are to anthrax, the objection does not seem very formidable.

The hæmatozoa of Nagana make their appearance, which is signalised by a rise in temperature, in the blood after an incubation period of 7 to 20 days, swimming actively among, and apparently "worrying" the corpuscles. With the progress of the disease they increase in numbers and, at the time of their host's death, may amount, in the dog, to 310,000 per cub. mm. of blood! Neither reproductive nor any other stages of the parasite are yet known, nor has it been found in the blood of any wild animal, inoculation of which (the best test for the presence of the hæmatozoon) has hitherto failed to produce disease.

Dr. Bruce has demonstrated that it is possible repeatedly to feed Tsetse on a healthy dog without producing disease in that animal—that is, the flies possess no specific venom; but that, if allowed to draw blood from a diseased animal or the carcase of one, they will communicate Nagana to any healthy animals on which they are subsequently fed, and the same result is obtained by inoculation of diseased blood, or, in dogs, by feeding them on the flesh of an animal dead of Nagana.

[1] *Compt. rend.*, 1858 (1), pp. 984–986.

[2] Leuckart, *Abh. Naturf. Ges.* Halle, 1858, pp. 145-226; and Pratt, *Arch. Naturg.* 1893, i. pp. 151-200.

[3] Osten Sacken, *Berl. ent. Zeitschr.*, 1887, pp. 17–27.

Thus far is the cause of the disease ascertained, as is the fact that the Tsetse can serve as a transmissive agent; but the natural source, other than diseased animals, which are not known to occur in a wild state, whence the flies obtain the parasite is still undetermined, nor is it proved that, unlike malaria, the disease cannot be acquired by breathing the air of the fly-country.

Repeating an old experiment of Captain Vardon's, Dr. Bruce has shown that a few hours' sojourn in a fly-district is sufficient exposure to induce the disease in a horse, which is prevented from eating and drinking there; but to complete the proof that the flies are indispensable as carriers of infection, it has further to be shown that domestic animals, if protected from their bites, can remain in such a region with impunity. As yet Dr. Bruce has not been able to make the experiment, but it may be observed that the concurrent testimony of many travellers, that animals can safely cross a fly-country on nights when the insects are inactive, goes to prove that the infection is not air-borne.

If Dr. Lingard's very voluminous report on Surra[1] be compared with the one under consideration, the points of identity between the two diseases will be found to be remarkably numerous, though not quite universal, and the fact that two such investigations are in progress by workers in touch with each other ought materially to quicken and extend the results arrived at. The complete life-history of the Surra parasite has yet to be

FIG. 2.—Hæmatozoa of Nagana in the blood of a horse (after Bruce).

published, and in discussing the ætiology of that complaint, Dr. Lingard attaches much importance to the eating of grass from swamps and marshy ground, and the drinking of stagnant water, and but little to fly-infection, which he considers to occur chiefly when healthy and diseased horses are crowded together. Such infection is, therefore, regarded as being of the purely transmissive form of fly-inoculation found in anthrax and possibly other septic diseases.

But a more intimate relationship of the fly and the parasite, at least in Nagana, suggests itself. In 1884, Dr. Manson showed[2] that the mosquito is the intermediate host of filaria, and applying his observations to the building-up of a working hypothesis as to the life-history of the malaria parasite (Laveran's hæmacytozoon) outside the body, he suggested, in 1894, that the mosquito also served as host for that form, and that the "flagellation-stage" assumed by a certain number of the parasites in drawn blood was an incipient change designed for life in the mosquito. In a course of lectures,[3] in process of being delivered as we write, for the unpublished text of which we have to return him our warm acknowledgments, this theory is developed in greater detail, and is supported by the observations of Surgeon-Major Ross, that examination of the blood imbibed from a malarial patient by mosquitoes shows, shortly after its extraction, that not a few, but the majority of parasites undergo flagellation. That the destiny of the flagella is still untraced is due to the extreme difficulty of the observations.

Dr. Manson's theory still awaits its final proof or disproof,

[1] "Report on Horse Surra," vol. i. (Bombay, 1893); and "Summary of further Report on Surra." (Bombay, 1895).

[2] *Trans. Linn. Soc.* (2), II. pp. 367-388, pl. xxxix.

[3] "The Goulstonian Lectures on the Life-History of the Malaria Germ outside the Human Body," delivered before the Royal College of Physicians of London, March 1896, by Dr. Patrick Manson.

and has been developed to a stage in which, failing the latter contingency, it is likely to be widely accepted. Assuming it to be correct, man occupies to the parasite the position of what he terms an "optional host," in which parasitism is neither necessary for nor inimical to the continuance of the species.

Another case of such possible relationship may be mentioned. In 1889, it was shown by Drs. Smith and Kilborne [1] that the so-called "Red-water" or "Texas fever" of cattle is a disease of malarial type due to the presence in the red blood-corpuscles of bodies presenting a certain similarity to Laveran's parasite. In this disease the sole form of infection known is by the agency of cattle-ticks (Ixodidæ), in which, notwithstanding their undoubted transmissive part, we believe the entozoon has hitherto not been detected in any stage.

Without attempting in any way to prescribe a line of research which Dr. Bruce is unlikely to overlook, it is impossible not to foreshadow the interest which will attach to an examination of the evolutions of the parasite in the body of the Tsetse, an examination which may end by showing that the insect, even if it possesses no specific virus in the older sense, may play an essential part in the economy of the hæmatozoon.

The symptoms, course, and pathology of Nagana are treated very fully by Dr. Bruce in a series of clinical cases, accompanied by charts indicating the variations of temperature, and the percentages of red blood-corpuscles and hæmatozoa. Suffice it here to say that the red blood-corpuscles may be reduced to one-third of their normal amount, and in one dog, at the point of death, bore to the parasites the proportion only of ten to one. He finds it invariably fatal in the horse, ass and dog—perhaps not necessarily so in cattle—in which it runs a much slower course. Two graphic and painful pictures are given of a donkey and a dog in the last stage of this distressing disease, and one is glad to learn that there is little suffering, and that the appetite rarely fails up to the last.

Of the new facts contained in this report, perhaps the most welcome is that Dr. Bruce finds that arsenic, so far as he has been able to try it, has a marked action on Nagana, causing disappearance of the hæmatozoa, reduction in temperature, and maintenance of the normal number of red blood-corpuscles. That it is a complete cure or prophylactic remains to be shown. The same result has been found in Surra, though the proportion of cases mentioned by Dr. Lingard as cured by treatment with arsenic is but small. This appears to be due partly to the extreme debility of many animals at the time of its first administration, and to the large and sometimes poisonous doses required. Its effects, nevertheless, are so remarkable as to give good ground for hoping that, when the limits of utility and safety of the drug, especially as a preventive, or in the early stages of disease, are determined, the trivial addition of a supply of arsenic to the traveller's outfit will free the African colonist of, perhaps, his greatest source of anxiety.

In Surra attempts have been made to treat the disease by inoculation or injection of filtered serum from affected animals. They have not proved successful, nor, while admitting the importance of the fact that the range of forms attacked by it and Nagana is limited, is there any *à priori* reason why they should succeed. The class of diseases here noticed, of which malaria may be taken as the type, is not caused by bacteria; and though it is known that the vitality of hæmatozoa is affected by alterations in the medium in which they live, as by the administration of quinine or arsenic, the ordinary methods of research and antitoxic treatment employed in bacteriology do not appear to be applicable to them.

In view of a tendency in the reports, both of Dr. Bruce and Dr. Lingard, to dwell in detail upon the clinical features of the respective diseases, it cannot be too strongly urged that, when once the pathogenic nature of the hæmatozoon has been established, these inquiries, in order to progress to a fruitful issue, must be conducted on zoological lines. The mode of reproduction, distribution and general bionomics of the hæmatozoon, and, in the event of its possessing more than an accidental connection with the Tsetse, the economy of that insect, these are the essential subjects of research: and little light will be thrown on them by any amount of laboriously-compiled clinical and pathological details.

It is to be desired that Surgeon-Major Bruce's further and more complete reports shall be republished in England, or at least made easily accessible to the many persons interested in African colonisation.

WALTER F. H. BLANDFORD.

[1] *Ann. Rep. U.S. Sec. Agric.*, 1889, pp. 38-91: 1890, pp. 92, 93, and 105-110; and following year.

THE ACTION OF LIGHT ON THE IRIS, DEMONSTRATED BY A NEW PUPILOMETER.

BROWN-SÉQUARD observed that, in the iris of batrachians and fishes, separated from the rest of the eye, the pupil contracts at the approach of a candle, a fact which he attributed to the direct action of the light on the muscular tissues of the iris, the nervous elements having already lost, as he thought, at the times of his experiment, all irritability. We may also ask if the iris of the living eye responds to the direct action of light.

This problem cannot be approached directly, because of the mobility of the eye and the extreme variability of the pupil.

My new pupilometer, constructed by the well-known engineer, Mr. Ph. Pellin, consists of a series of three tubes of increasing diameter, commencing with the ocular tube; the first is provided with a screen perforated by a very small hole, and with an adjustable frame which may be removed or brought near in a manner to fix the eye at the required distance (12·8 mm.), of the anterior focus of the eye. The last tube is closed by a ground glass, 10 cm. in diameter; on the surface of this glass appear black and white circles with numerical graduations. All the peripheric zones of the ground glass which are not perceived by the retina illuminate the iris. In this manner I am able to distinguish the effect produced upon the pupil by suppressing the illumination of a portion of the iris by means of opaque rings of blackened copper successively arranged upon the glass, the apertures of which are precisely equal to the apparent surfaces of the pupil, and then suddenly removed. For the retina nothing is changed by changing these rings, since the opening of each ring equals precisely the apparent surface of the luminous admission; for the iris, on the contrary, all is changed, since the opacity of the interposed rings prevents the luminous rays from reaching it.

The experiment made under these conditions proves that there is almost always a dilatation of the pupil when the iris is withdrawn from the light. The process may be described as follows. The subject is requested to indicate the largest concentric circle that he is able to distinguish on the luminous background, whereupon I place against the background an opaque ring, the opening of which equals precisely the said concentric circle; after a few moments I remove the ring, and then the subject generally remarks the coincidence of the apparent surface of his pupil with a concentric circle of much greater diameter. I have noticed but two exceptions to this rule where the result was a contraction instead of enlargement. The dilatation varies from $\frac{1}{8}$ to $\frac{1}{18}$ of 1 mmq. for 1 mmq. of iris withdrawn from the light, and such dilatation has generally been observed to be greater for the dark than for the light iris.

The great majority of dark eyes which prevails in southern latitudes is perhaps a provision of nature to thus protect the eye from the effect of too abrupt changes of luminous irritation.

In any case the variations of dimensions of the iris are much less when it is the iris alone which is subjected to light than when the iris and the retina are influenced together. It may be shown, for instance, that if 1 mmq. of the centre of the retina be withdrawn from the light, the iris is capable of increasing in size from 1 to 16 mmq.

If, with the pupilometer of Robert Houdin, we observe the pupil of one eye while the iris of the other is obscured, we remark on the said pupil a dilatation from half to quarter of a millimetre in diameter; this goes to prove that the action of light on the iris is due, in part at least, to a reflex of cerebral origin; but, on the other hand, we do not yet possess sufficient knowledge of the anatomy of the iris to enable us to say whether these variations are due to the direct action of light on muscular elements (as supposed by Brown-Séquard) or to the action of nervous centres yet unknown belonging to the iris.

I have studied the influence of a coloured disc on the pupil, allowing the coloured light to strike the retina, in which cases I remarked that the more luminous the colours the less the dilatation of the pupil: yellow and green, for instance, cause a greater dilatation than red or blue. Again, I have remarked just the contrary. The same contradictions, which may be explained by the fatigue of the eye, are manifest when we examine the isolated action upon the iris of rings cut from the same block as the aforesaid coloured disc.

I have also endeavoured to find with the new pupilometer the

relation existing between the pupillary contraction and the illumination of the retina.

The discovery of the direct action of light upon the iris leads to a number of curious deductions.

1. We are now able to explain the cause of the intense photophobia which characterises the iritis, and it is probable that the examination of the iris by the new pupilometer from the point of view of its proper excitability will be very useful in the diagnosis of diseases of the eye.

2. It shows that our photometric measurements must involve a systematic error, although slight. When the eye is directed towards the most luminous of two lights of different intensities the iris contracts, tending thus to equalise for the retina the two lights. It is in this movement of the iris perhaps that we should seek an explanation of the contradictions which we meet continually between the data of our photometric processes and the data furnished by sensitive plants employed in the measurement of light. We know, for instance, that a branch of *vitia sativa* placed between two lights equal for our eye and equidistant from each other tends invariably to incline towards one of them.

CHARLES HENRY.

IMMUNISATION AGAINST SERPENTS' VENOM, AND THE TREATMENT OF SNAKE-BITE WITH ANTIVENENE.[1]

I.

FROM a remote period of antiquity, there has been enmity between the human race and serpents, and, in a literal sense, man has bruised the head of the serpent, and the serpent has bruised the heel of man. This long-continued feud has not yet resulted in victory for either side. Venomous serpents still annually destroy the lives of tens of thousands of human beings, and, in self-defence, tens of thousands of serpents are annually slain by man.

The progress of knowledge has greatly increased the means for protecting mankind against the death-producing effects of many diseases; and, although these means have been liberally employed in the contest against venomous serpents, none of them has hitherto been found sufficient.

The reality of the contest is appreciated when we find pervading medical literature from its earliest beginnings—from the time of Pliny and Celsus—to the present time, disquisitions on the treatment of the bites of venomous serpents, and lengthy descriptions of the numerous remedies, organic and inorganic, that have been used for this purpose. Although extended experience and the application of the scientific methods of the present day, have resulted in showing that each of these remedies had been recommended on insufficient grounds, we may hesitate in pronouncing their recommendation to have been premature, in view of the impossibility of waiting, in the presence of imminent dangers, until accurate demonstration has been obtained by the usually tardy and laborious processes of science.

Let me pause here for a few minutes to indicate the practical importance of a scientific demonstration of the value of any remedy that is used in the treatment of snake-poisoning.

When a serpent inflicts a wound, I need scarcely say that it is not the wound, but the venom introduced into it which causes the symptoms of poisoning, and the death that may result. This venom is now known to be a complex mixture, containing several non-poisonous as well as poisonous substances. The latter are not ferments and have no power of reproducing themselves in the body, but they are substances that produce effects having a direct relationship to the quantity introduced into the body. This quantity in the case of each serpent varies with its size and bodily and mental condition; with the nature of the bite—whether both fangs or only one have been introduced, whether they have penetrated deeply or only scratched the surface; and with other circumstances related to the serpent, such as whether it had recently bitten an animal or not, and thus parted with a portion or retained the whole of the venom stored in the poison glands.

A bite may, therefore, result in very little danger, or it may be rapidly fatal; but, in order to produce death, there must have been introduced into the tissues at least a certain quantity of venom, which is spoken of as the minimum-lethal quantity or dose. The minimum-lethal quantity for the animal bitten, again, is different for different species of animals, and different also for different individuals of the same species, the chief cause of difference between animals of the same species being the body weight of the individual, the quantity required to produce death being very exactly related to each pound or kilogramme of weight.

If even a minute fraction below the minimum-lethal has been introduced into the tissues by an effective bite, death will not follow, although serious and alarming symptoms will be produced of exactly the same kind as those which follow a bite which terminates fatally.

How then can we be assured, in any case of snake-bite in man, that a quantity of venom sufficient to produce death has been introduced? It is impossible to answer this question except by the result. If a quantity less than the minimum-lethal has been introduced, although the gravest symptoms may be produced, the patient will recover whatever remedies are administered, provided, obviously, that the remedies have not been so injudiciously selected or used that they themselves, and not the insufficient quantity of venom, produce a fatal termination. The recovery of a patient after the introduction of less than the smallest quantity of venom capable of producing death, has thus too often been attributed to the remedies that have been administered; and consequently, as, indeed, is exemplified in the treatment of many diseases, a large number of substances have acquired an unjust reputation as antidotes. The list of antidotes has, accordingly, become a very large one; but when their pretensions have been subjected to sufficient tests, the verdict is that all of them are valueless to prevent death when even the smallest quantity of venom required to produce death has been received by an animal.

Without entering into details, I will content myself with reproducing the opinion of Sir Joseph Fayrer, that, "after long and repeated observations in India, and subsequently in England, I am forced to the conclusion that all the remedies hitherto regarded as antidotes are absolutely without any specific effect on the condition produced by the poison."

But while medical practice and science, in each period of its development, has thus failed to protect man against this ancient enemy, legendary traditions, the tales of travellers and of residents among nations and tribes existing outside of the civilisation of the time, at least suggest that, by means apart from the use of remedies, some measure of success may actually have been obtained.

Many of these legends and statements are probably of great significance, and, in connection with facts derived from experiment, which to-night I have to describe, they possess a deep interest.

We learn from these legends that from a remote period of time the belief has existed that a power may be acquired by man of freely handling venomous serpents, and even of successfully resisting the poisonous effects of their bites.

The Psylli of Africa, the Marsi of Italy, the Gouni of India, and other ancient tribes and sects, were stated to have been immune against serpents' bites, and this immunity has been explained on the supposition that serpents' blood was present in the veins of the members of these tribes and sects.

In more modern times and, indeed, at the present day, the same belief is expressed in the writings of many travellers. In "A New and Accurate Description of the Coast of Guinea," by William Bosman, published in 1705, an account is given of the great "reverence and respect" of the negroes for snakes, worshipped by them as gods; in connection with which the following statements are made. "But what is best of all is that these idolatrous snakes don't do the least mischief in the world to mankind; for if by chance in the dark one treads upon them, and they bite or sting him, it is not more prejudicial than the sting of millipedes. Wherefore the natives would fain persuade us that it is good to be bitten or stung by these snakes, upon the plea that one is thereby secured and protected from the sting of any poisonous snake" (p. 379).

At Southern Africa, the Rev. John Campbell, in 1813, observed that it was "very common among the Hottentots to catch a serpent, squeeze out the poison from under his teeth, and drink it. They say it only makes them a little giddy, and imagine that it preserves them afterwards from receiving any injury from the sting of that reptile" (p. 401).

Drummond Hay, in his work on Western Barbary, pub-

[1] An address delivered at the Royal Institution of Great Britain, on Friday, March 20, by Prof. Thomas R. Fraser, F.R.S.

lished in 1844, gives a description of the performances by members of a sect of snake-charmers, called the Eisowy, who freely handled, and allowed themselves to be bitten by serpents proved to be venomous by a rapidly fatal experiment performed on a fowl. At the termination of the exhibition, the Eisowy, apparently as a usual part of the performance, "commenced eating or rather chewing" a poisonous snake, "which, writhing with pain (to quote Mr. Hay's words), bit him in the neck and hands until it was actually destroyed by the Eisowy's teeth." He states that, on another occasion, at Tangier, a young Moor, who was witnessing the performances of a snake-charmer, ridiculed his exhibition as an imposture, and having been dared by the Eisowy to touch one of the serpents, the lad did so, was bitten by one of them, and shortly afterwards expired. In connection with my subject, a special interest is attached to the account given by Mr. Drummond Hay, and repeated in its main features by Quedenfeldt in the *Zeitschrift für Ethnologie* of 1886, of the origin of this Eisowy sect, and of the immunity which they claim. The founder, Seedna Eiser, was being followed through the desert of Soos by a great multitude, who, becoming hungry, clamoured for bread. On this, Seedna Eiser became enraged, and turning upon them he uttered a common Arabic curse, "Kool sim," which means "eat poison." So great was their faith in the teaching of the saint, that they acted upon the literal interpretation of his words, and thereafter ate venomous snakes and reptiles; and from that time they themselves and their descendants have been immune against serpents' bites (p. 65).

Dr. Honigberger, in his "Thirty-five Years in the East," published in 1852, relates the incident of a faqueer who was bitten by a serpent, and to whom he at once sent medicines which he judged likely to prevent the ill-effects of the venom. "On the same afternoon," he writes, "I visited him and found him in good spirits. I at first attributed the circumstance to the effect produced by the remedies I had sent him, but was surprised on hearing that he had not taken them, he being of opinion that the venom of the serpent was incapable of affecting him, inasmuch as he had often been bitten by serpents without having sustained any injury." On the suggestion of the faqueer, the same serpent, which had been caught and retained, was allowed to bite him again, and afterwards to bite a fowl. This fowl was taken home by Dr. Honigberger, and he found it dead on the following morning, "although the faqueer, who was bitten first, was quite well" (p. 135).

Nicholson, in his work on "Indian Snakes" (1875), and Richardson, in his "Landmarks of Snake-poison Literature" (1885), also narrate instances, the latter with obvious disbelief in their reality, suggesting that snake-charmers may possess some means for protecting themselves against the bites of venomous serpents.

Many other examples might be quoted in which this suggestion is made. The attention which has been drawn to the subject during the last twelve months has prompted the publication of other instances, such as that related by Dr. Bawa, of a Tamil snake-charmer who, in the course of his performances, was bitten by a cobra without any effect, while an onlooker, foolishly repeating the performance, was bitten by the same cobra, and died in three hours; and the description given by M. D'Abbadie, in a recent issue of the *Comptes rendus*, of the custom, recently prevailing at Mozambique, of inoculating with serpents' venom, under the firm conviction that protection is thereby produced against the effects of serpents' bites.

It may be instructive to associate with these statements the belief that venomous serpents are themselves protected against the effects of bites inflicted upon them by individuals both of their own and of other species. On mere anatomical grounds, it is difficult to understand how serpents could escape the absorption of their own venom through mucous surfaces, even admitting that absorption of venom does not occur in normal conditions of these surfaces. Venom must, however, be so frequently introduced into their bodies, in situations where absorption could not fail to occur, by the bites inflicted upon them by other serpents, that the conclusion seems inevitable that they possess some protective quality, without which, probably, no venomous serpents would now be in existence. Not only have many general observations been made in favour of this belief, but it has been supported by direct experiments, such as those made by Fontana of Tuscany more than a century ago, and by Guyon, Lacerda, Waddell, Kaufmann, and Sir Joseph Fayrer.

This, and other evidence, pointing to the existence of protection against venom, not only in serpents themselves, but also, in certain exceptional circumstances, in human beings, several years ago originated a wish to investigate the matter. It was obviously suggested that if protection occurs, it must be caused by some direct result of the absorption of venom; and, therefore, that its existence could be proved or disproved by experiment. In the former event, the first steps would already have been taken to obtain, by further experiments, results likely to be of value in the treatment of poisoning by serpents' venom, and, indeed, likely to be of suggestive importance in even the wider field of general therapeutics.

The general plan to be followed in the first stages of the investigation was obviously suggested by some of the statements I have reproduced; for they indicate that individuals might become accustomed to, or protected against the effects of serpents' bites, by the introduction into their bodies of a succession of doses of venom, no one of which, necessarily, at the beginning of the process was so large as the minimum-lethal. A consideration also of the facts, proving the possession of protection on the part of venomous serpents themselves, indicated the same plan of procedure; for, equally obviously, these serpents, from an early period of their existence, must absorb venom from their own gradually-developing poison-glands, until, in the course of time, they had acquired sufficient protection to remain unaffected by the larger quantities which the now fully-developed glands would introduce into their bodies.

My first supplies of cobra venom were obtained in 1869, from the late Dr. Shortt, of Madras, and in 1879 from Surgeon-Colonel Moir, of Meerut. They were in very small quantity, but with them I was able to satisfy myself that, by a succession of minute doses, animals became able to receive the minimum-lethal dose without any distinct injury. At this point, however, the supply of venom failed, and the observations could not then be carried further. It became evident that until large quantities of venom had been obtained, definite results could not be hoped for.

It was not until several years afterwards that a sufficient supply had been gradually accumulated, by further small quantities received from Sir Joseph Fayrer, the Thakore of Gondal, and Dr. Phillips; and by larger quantities from Sir William Mackinnon, Director-General of the Army Medical Department, and especially from Surgeon-Colonel Cunningham, of Calcutta, who for many years has been engaged with much success in the study of venoms and their antidotes. Within the last few months, and subsequently to the publication of some of the experimental results which had by this time been obtained, the India Office has also placed at my disposal a considerable quantity of venom, which had been collected by Dr. Hankin, of Agra, at the request of Dr. Cleghoorn, Surgeon-General with the Government of India.

But, besides these specimens of the venom of the cobra of India, I have also been fortunate in obtaining specimens of venoms from other parts of the world.

From America, Dr. Weir Mitchell, of Philadelphia—whose work on the chemistry and physiology of serpents' venom constitutes the great advance of the century on the venom of viperine serpents—has supplied me with the venom of three species of rattlesnakes, viz. *Crotalus horridus*, *C. adamanteus*, and *C. durrisus*, and also with a specimen of the venom of the Copper Head (*Trigonocephalus contortrix*).

From Australia, Dr. Thomas Bancroft, of Brisbane, has at various times sent specimens of the venoms of the black snake (*Pseudechis porphyriacus*), the brown snake (*Diemenia superciliosa*), and of a large unidentified snake of the Diamantina district of Queensland (probably a new species of Diemenia).

From Africa, the kindness of Mr. Andrew Smith, a distinguished naturalist of Cape Town, of Dr. Brook, of the Orange Free States, and of Dr. John Murray and Mr. Van Putten, of Cape Colony, has placed at my disposal small quantities of the venom of the puff adder (*Vipera arietans*), the night adder (*Aspidelaps lubricus*), the yellow cobra (*Naja haie*), and the "Ring Hals Slang" or "Rinkas" (*Sepedon hæmachates*).

In the meantime, however, the results of experiments on the inoculation of the toxines of diseases, as well as of proteid toxines of vegetable origin, had suggested to several observers that serpents' venom, because of its chemical analogies with several of these substances, might possibly be found capable, like them, of producing immunity against the effects of poisonous doses; and

further important evidence has thus been obtained in favour of the reality of the protection to which I have referred.

Sewall, in 1886, undertook an investigation with the object of determining if immunity against the fatal effects of rattlesnake venom could be produced by the inoculation of repeated doses, each too small to produce ill-effects. The experiments were made on pigeons, and he succeeded in proving that immunity could be secured to the extent, at least, of protection against seven times the minimum-lethal dose. Kanthack made a similar series of experiments in 1891, which allowed him to conclude that rabbits may be accustomed to resist lethal doses of cobra venom. Working with the venom of vipers, Kaufmann in 1891, and Phisalix and Bertrand in 1893, obtained experimental evidence of the possibility of producing a definite, though not high degree of resistance against the toxic effects of this venom. In the following year, Calmette, continuing some earlier observations which had led him to express the opinion that protection against snake venom could not be produced, published evidence confirming the results of previous investigators, but also showing that a higher degree of protection could be secured than they had obtained, for he succeeded in administering to each of several rabbits, within a period of eight months, a total quantity of from 30 to 35 milligrammes of venom.

In 1894, also, both Phisalix and Bertrand and Calmette obtained evidence of the power of the blood-serum of protected animals to counteract the effects of venom. Calmette at the same time claimed that hypochlorite and chloride of calcium were antidotes of considerable value; and in a later publication, he showed that the blood-serum of animals immunised by the administration of venom possesses a certain degree of antidotal efficacy against the toxines of several diseases.

In the case of many of the venoms which I have had the good fortune to obtain, the quantity at my disposal was not sufficient for experimental examination on the plan that seemed desirable, and, besides, the examination of each of them would require several months of work. The venoms that have as yet been used are four in number, those, namely, of the cobra of India (*Naja tripudians*), of the *Crotalus horridus* of America, of a large colubrine snake, probably a species of *Diemenia* from Queensland, Australia, and of the *Sepedon hæmachates* of Africa. They are, therefore, those of the most deadly of the poisonous serpents of Asia, America, Australia, and Africa, respectively; and, further, they are representative of the chief differences that occur in the composition and action of venoms, for they are derived from members af the two great groups of the colubrine and viperine serpents. My supply of cobra venom, however, being much larger than that of any of the others, this venom was chiefly used in the experiments.

An essential preliminary to exact investigations with active substances must always be the determination of the activity of the substances. The only convenient method for doing this is to define the smallest dose capable of producing death for any given weight of animal—that is, the minimum-lethal dose. The venoms in their natural liquid state are unstable, and they are also inconstant in activity, mainly because of variations in the quantity of the water which they contain. Dried venoms have therefore been used in all the experiments. The cobra venom has, however, nearly always been received in the form of a dry solid; but when this was not so, it has been dried *in vacuo* over sulphuric acid.

Experiments were made with it on several animals—as the frog, guinea-pig, rabbit, white rat, cat, and the innocuous grass snake of Italy (*Tropedonotus natrix*). Very considerable differences were found to occur in the minimum-lethal dose for each of these animals. For the guinea-pig, the minimum-lethal dose per kilogramme was ·00018 grm.; for the frog, ·0002 grm.; for the rabbit, ·000245 grm.; for the white rat, 00025 grm.; for the cat, somewhat less than ·005 grm.; and for the grass snake, the relatively large dose of ·03 grm.[1] Cobra venom thus takes a position among the most active of known substances, rivalling in its lethal power the most potent of the vegetable active principles, such as aconitine, strophanthin or acokantherin.

These facts having been ascertained, attempts were next made to render animals proof against lethal doses, by administering to them a succession of gradually increasing non-lethal doses. These were, for the first few doses, in some of the experiments, one-tenth of the minimum-lethal, in others one-fifth, in others one-half of the minimum-lethal, and in others almost as great as the minimum-lethal. At varying intervals, the doses were repeated, and by-and-by gradually increased, until the actual minimum-lethal had been attained. The subsequent doses, by gradual increments, exceeded the minimum-lethal, and after five or six times the minimum-lethal had been reached, it was found that the increments could be increased so that each became twice, four times, and latterly even five times the minimum-lethal, and still the animal suffered little, and, in many cases, no appreciable injury.

This brief statement, however, does not represent the experimental difficulties that were encountered. It describes the course of events in the altogether successful experiments. Non-success, however, was frequent, and many failures occurred before experience indicated the precautions and conditions that are necessary for success.

Serpents' venom exerts what may broadly be described as a duplex action. It produces functional disturbances unassociated with visible structural changes, and it also produces obvious structural changes. The latter are of a highly irritative character, causing intense visceral congestions in the lungs, kidneys, and other organs, and when the venom is given by subcutaneous injection, on all the structures of the skin and subjacent parts. There are apparently also some definite changes produced in the blood, with regard to which several important facts have been discovered by Dr. Martin, of the University of Sydney, and by Surgeon-Colonel Cunningham, of Calcutta. Irritative effects are obviously produced by cobra venom, even in non-lethal doses, and with greatly increased virulence by doses that exceed the minimum-lethal: but, in respect to this action, the other three venoms used are greatly more active than the venom of the cobra. Evidence was obtained to indicate that in the process of immunisation a diminution occurs in the intensity of these local actions; but this diminution does not proceed so rapidly as that in the unseen functional or other changes which are the more direct causes of death; and, further, the local irritative changes, after having been produced, are slower to disappear than the unseen functional disturbances. Until these facts had been appreciated, and, indeed, even with the adoption of precautions suggested by them, frequent failures occurred. The apparently contradictory results, accordingly, were obtained of the production, by gradually increasing doses, on the one hand, of a protection against quantities much above the minimum-lethal, so perfect that no apparent injury was caused; and, on the other hand, when the intervals of time separating successive doses had been too brief, of an intolerance so decided that death was produced by the last of a succession of gradually increasing doses, no one of which was so great as the minimum-lethal. The latter unfortunate event was frequently displayed in frogs and guinea-pigs, and attempts to carry immunisation in them to a high point usually resulted in failure.

Notwithstanding these difficulties, however, such gratifying results have been obtained as that rabbits could at last receive, by subcutaneous injection, so much as ten, twenty, thirty, and even the remarkable quantity of fifty times the minimum-lethal dose, without manifesting any obvious symptoms of poisoning.

Almost the only observable phenomena were a rise in the body temperature, which continued for a few hours after the injection, and which contrasts with the fall that occurs after the administration of even non-lethal doses, in non-protected animals; and a loss of appetite, which usually, though not invariably, occurred, and was probably the cause of a temporary fall in weight during the day or two days succeeding each injection. On the other hand, during the process of successful immunisation, the animals increased in weight, fed well, and appeared to acquire increased vigour and liveliness (Fig. 1).

It is marvellous to observe these evidences of the absence of injurious effects, and even of the production of benefit in an animal which, for instance, has received in one single dose a quantity of venom sufficient to kill, in less than six hours, fifty animals of the same weight, and in the course of five or six months a total quantity of venom sufficient to destroy the lives of 370 animals of the same species and weight.

With the cobra venom, I have also immunised cats and white rats, both by subcutaneous and by stomach administration; but the significance of the latter method of administration will be afterwards considered. A horse has also been immunised; and I have to express my obligations to Principal Williams and Prof. W. Owen Williams for granting me the accommodation of their

[1]

Guinea-pig,	nearly	½ millig.
Frog,		⅓ ,,
Rabbit,	nearly	¼ ,,
White rat,		¼ ,,
Kitten (6 weeks),		2 millig.
Cat,		5 ,,
Grass snake,		3 centig.

establishment, and to Mr. Davis, also of the New Veterinary College, for much valuable assistance.

Following the same plan of research with the three other venoms, it was found that for rabbits the minimum-lethal dose per kilogramme of the Diamantina venom is ·0015 grm.; of the venom of *Sepedon hæmachates*, ·0025 grm.; and of the venom of Crotalus ·004 grm.[1] The Crotalus venom is, in its purity, altogether comparable with the cobra venom; and the determinations, therefore, show that cobra venom is sixteen times more powerful than Crotalus or rattlesnake venom. This venom, as well as the two others, however, much exceed cobra venom in the intensity of their local action. When death is produced by Crotalus venom, the subcutaneous tissues become extensively infiltrated with a large quantity of blood and of blood-stained serum, the underlying muscles are reduced to an almost pulpy blood-stained substance, and post-mortem decomposition occurs very soon after death. Similar changes in the subcutaneous tissues, but to a rather less degree, are caused by the Diamantina venom, and in addition, hæmaturia, or more probably hæmoglobinuria, was invariably produced by lethal and by large non-lethal doses. I mention these circumstances to indicate the perfection of the protection which is produced by the administration of successive gradually increasing doses: for they can be so adjusted that a dose of the Diamantina venom, even fifteen times larger than the minimum-lethal, may be administered without producing more than an inconsiderable degree of local destructive effect.

Experiments have also been made by which it has been demonstrated that when an animal has acquired a resistant power over the minimum-lethal dose of one venom, that animal is also able successfully to resist the lethal action of a dose above the minimum-lethal of other venoms. To a rabbit protected against cobra venom, a dose above the minimum-lethal of Sepedon venom has been administered; to rabbits protected against Crotalus venom, doses above the minimum-lethal of Diamantina and of cobra venoms have been given; to rabbits protected against the Diamantina venom, doses above the minimum-lethal of Crotalus and Sepedon venoms have been given, and in each case the animal has recovered, and but few symptoms of injury were produced. At the same time, in other experiments, indications were obtained that animals protected against a given venom are capable of resisting the toxic effect of that venom more effectually than the toxic effect of other venoms.

The experiments have not yet proceeded sufficiently far to show for what length of time the protection conferred by any final lethal dose may last. It has been discovered, however, that protection lasts for at least a considerable period of time, even when the last protective dose has not been a large one. For example, to a rabbit which had last received four times the minimum-lethal dose of cobra venom, twice the minimum-lethal dose was administered thirty-four days subsequently; while to another rabbit, which had last received twice the minimum-lethal dose of Crotalus venom, the same dose of this venom was administered twenty days subsequently, and in each case the second dose failed to produce any toxic symptom.

Having thus succeeded in producing a high degree of protection in animals against the toxic effects of serpents' venom, the blood-serum of these animals was, in the next place, collected for the purpose of testing its antidotal properties. In this portion of the investigation, the method followed was essentially the same as that described in a communication made by me to the Royal Society of Edinburgh in 1871, on "The Antagonism between the Actions of Physostigma and Atropia," as it appeared to be the most direct method for obtaining accurate knowledge of the value of an antidote.

A few preliminary experiments were, however, early made with the serum of animals in whom the protection had not been carried to a high degree, and they were sufficient to show that antidotal properties are possessed even by this serum. It soon became apparent that in order to obtain some reasonable approximation to constancy in the conditions of the experiments, it was necessary that the serum should be in such a state that it would remain unchanged during at least several weeks. It was found that this could be insured, without any appreciable loss of antidotal power, by drying the freshly-separated serum in the receiver of an air-pump, over sulphuric acid.

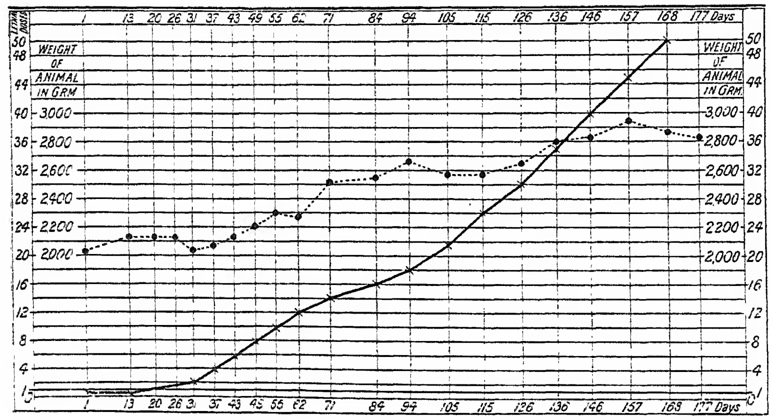


Fig. 1.—Immunisation of a rabbit against 50 times the minimum-lethal dose of cobra venom. The crosses connected by the continuous line represent administrations of venom. The dots connected by the interrupted line represent the weights of the animal.

A perfectly dry and easily pulverisable solid is thus obtained from which a normal serum can readily be prepared as required, by dissolving a definite quantity of the dry serum in a definite quantity of water. The dry substance is on the average equivalent to about one-tenth of the weight of the liquid serum. I have found that, without any special precautions, it retains its antidotal power unimpaired for at least a year, and it is probable that it may be kept unchanged for an unlimited period of time.

To this antidotal serum, whether in the dry form or in solution, I have given the name "Antivenene," a name which, notwithstanding etymological objections, has the advantages of brevity and freedom from ambiguity.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

At the graduation ceremony of the University of Glasgow on Tuesday, the honorary degree of LL.D. was conferred upon Mr. Thiselton-Dyer, F.R.S., and Prof. Andrew Gray.

Prof. J. Perry, F.R.S., Professor of Applied Mathematics and Mechanical Engineering at the Finsbury Technical College, has been appointed to the vacant chair of Mechanics and Mathematics at the Royal College of Science, London.

At a meeting of the Court of Edinburgh University on Tuesday, it was announced that the trustees of the late Earl of Moray have allocated the sum of £20,000 as a capital endowment fund for the promotion of original research in that university. The Court resolved to record their deep sense of the munificence of the gift and their cordial approval of the purpose towards which it is to be applied.

In the House of Commons on Thursday last, Sir A. Rollit asked the Vice-President of the Committee of Council of Education whether it was intended to introduce a Bill in pursuance of the recommendations, with or without modifications, of the Gresham Commission for the reorganisation of the University of London; and, if so, when and in which House. In reply, Sir J. Gorst said he could not give any definite answer to the question. The matter is however under consideration, and we are informed that Lord Playfair's Bill will be reintroduced shortly with small changes.

[1] Diamantina venom, 1½ milligramme.
Sepedon hæmachates, 2½ ,,
Crotalus horridus, 4 ,,

THE *Calendar* for 1895–96 of the Queen's College, Galway, contains an alteration in the statutes referring to scholarships. We notice that from the beginning of the Session 1896–97, all scholarships and prizes will be open to students of either sex; junior scholarships in arts of the second year will be tenable for one year only. After the close of the Session 1897–98, the third year's scholarship in law and the senior scholarship or exhibition in the same subject will be abolished.

THE tenth summer meeting of the Edinburgh University Extension Movement will be held at University Hall, Edinburgh, from August 3 to August 29. Among the courses of lectures which have been arranged are philosophy and social science, by Prof. Patrick Geddes; the relation between science and philosophy, by Dr. R. M. Wenley; African scenery as influenced by climate, by Mr. Scott Elliot; psychology, education and physiology, hygiene, biology, geography and geology. There will also be several conferences for the discussion of educational problems of the present day. The comprehensive character of the programme should attract a large number to the meeting.

IN the House of Commons on Tuesday, Mr. Carvell Williams asked the First Lord of the Treasury whether the Parliamentary grant to King's College would not only be restored, but considerably increased; and, if so, whether provision was made for such increase in the present Estimates or whether it would be otherwise provided. In reply, Mr. Balfour said no increase was proposed this Session in regard to King's College. In accordance with an undertaking given by the Chancellor of the Exchequer to a deputation which waited upon him, he has appointed three gentlemen, Mr. T. H. Warren, President of Magdalen College, Oxford, Prof. D. G. Liveing, and Mr. Chalmers, of the Treasury, to visit the colleges sharing in the grant made to universities and colleges in Great Britain, and to investigate the character and quality of the university work done, and to inquire generally into the position which each college occupies both financially and in other respects. When their report is received, which the Chancellor of the Exchequer expects will be some time in the autumn, he will be in a position to judge whether a case has been made out for recommending Parliament to increase the sum to each of the colleges sharing in the grant.

FROM *Science* comes news of a notable extension of the University of Pennsylvania, by the establishment of a large number of graduate scholarships and fellowships. Provost Harrison gave 500,000 dols. to the university last June, "for the encouragement of liberal studies and the advancement of knowledge." The specific purposes of the fund are as follows: (1) The establishment of scholarships and fellowships intended solely for men of exceptional ability. (2) The increasing of the library of the university, particularly by the acquisition of works of permanent use and of lasting reference to and by the scholar. (3) The temporary relief from routine work of professors of ability in order that they may devote themselves to some special and graduate work. (4) The securing of men of distinction to lecture, and for a time to reside at the university. Our contemporary states that in pursuance of the end in view in the foundation, definite action has been taken in the establishment of a considerable number of graduate scholarships and fellowships. The recommendations which were made regarding these have been approved and will now go into force. There are eight graduate scholarships giving free tuition and 100 dols. open to those coming from the liberal courses in the college of the university; and there are, with the Hector Tyndale Fellowship in Physics, now fifteen fellowships, fourteen of which, coming from this foundation, are open to students of any university. The amount of the tuition deducted from the full value of the fellowship (600 dols.) does not go into the general funds of the university, but may be used for the purchase of books or apparatus which will aid the student in his work, or may be used in the publication of theses. A somewhat unusual feature is the establishment of senior fellowships, open only to those who have taken the Doctor's degree in the University of Pennsylvania. This amounts to the introduction, in a modified form, of the "Docent" system of German universities, the object being not at all to use the Senior Fellow as a teacher for the sake of the value he may be to the university, but to test him and give him an opportunity to do a little teaching in the direct line of his special work. From the Senior Fellowships there is no reduction for tuition. This gives eight Graduate Scholarships, fifteen Fellowships, and five Senior Fellowships, making twenty Fellowships in all. Fourteen of the Fellowships are open to men from other institutions, but the Senior Fellowships are limited to those having taken the Doctor's degree from the university in order that some of the best men may be kept in residence there as long as possible, and their influence felt among the students.

SCIENTIFIC SERIALS.

American Journal of Science, March.—Trinidad pitch, by S. F. Peckham and Laura A. Linton. This paper gives an account of the physical and chemical properties of pitch from the Pitch Lake of Trinidad, together with a map of the lake itself. A dry sample of the true lake pitch contained 34·2 per cent. petrolene, 18·8 per cent. asphaltene, 11·4 per cent. of other organic matter, and 35·6 per cent. of inorganic matter. The pitch as it occurs is a unique substance found nowhere else in nature. It consists of a mixture of bitumen, water, sand, decayed vegetation, and gas in such definite proportions that within certain limits the composition of the entire mass is uniform.—Proofs of the rising of the land round Hudson Bay, by Robert Bell. The old shore-lines in the provinces of Ontario and Quebec slope upward in a north-easterly direction at rates varying in different regions from a few inches to a foot and even two feet per mile. Many former landing-places about the bay are now high and dry. The rising is apparently still in progress.—Experiments upon the kathode rays and their effects, by A. W. Wright. In developing "shadowgraphs," it is better not to use any alkaline accelerator at all until just at the end of the process. Röntgen rays passing through glass walls do not show magnetic deflection or mutual repulsion; but when they are made to pass through gold-leaf instead, they show traces of these phenomena, probably owing to the fact that they carry with them small portions of volatilised and electrified metal.—Triangulation by means of kathode photography, by John Trowbridge. The principle of triangulation may be applied to kathode photography when determining the situation of metallic particles in the body. By using two vacuum tubes in different positions, two pictures of, say, a bullet embedded in a hand may be obtained, and their distance apart gives the depth at which the bullet may be sought.—Notes of observations on the Röntgen rays, by H. A. Rowland, N. R. Carmichael, and L. J. Briggs. Some photographs of a coin obtained by Röntgen's method showed no penumbra when the coin was 2 cm. from the plate. In a very high vacuum tube the source of the active rays was distinctly traced to the *anode*.

THE *Meteorologische Zeitschrift* for March contains some interesting results of meteorological observations made at Boroma, on the Zambesi, lat. 16° S., long. 33° 12′ E., in the years 1891–92. The most prominent feature of the climate is the contrast between the dry and the wet seasons. The approach of the rainy season is announced by lightning in the north and north-east during October; rain commences in November, and continues, on and off, for about five months; hail also occasionally occurs during thunderstorms. The dry season commences in April, and until the following November no measurable quantity of rain falls. It is noteworthy that during seven dry months, under a tropical sun, vegetation is not arrested, although even slight dew is very rarely observed. The daily barometric range is very regular, and amounts to about 0·15 inch. The atmospheric waves are so similar that the barometric curves overlie each other as nearly as possible; depressions such as are frequent in our latitudes do not occur at any part of the year; even the passage of thunderstorms is not shown upon the barograph traces. The absolute maximum temperature recorded was 109°·9, in November, and the minimum 54°·5, in August. The annual rainfall amounted to 29·6 inches, of which 10 inches fell in December. The greatest amount observed in twenty-four hours was only 1·9 inch.

THE last fascicule of the Memoirs (*Travaux*) of the St. Petersburg Society of Naturalists (vol. xxv. livr. 2), which is entirely given to the works done in the zootomical laboratory of the St. Petersburg University, contains an interesting monograph, by B. Sukatchoff, on some new forms of sponges from Lake Baikal. The dredgings were made in the south-western part of the lake, near the issue of the Angara, by means of an apparatus similar to the one used by the *Challenger* expedition, the greatest depth reached being 492 feet. The greatest depth at which sponges were found was 273 feet. Most of the sponges obtained belong to already known species of *Lubomirskia*, described by

Dybowski in 1880; but some of them must be considered as new varieties, or as new species of the same genus. Thus the author describes and figures the new varieties: *Lubomirskia baicalensis*, Pall., var. ϵ, and *Lubomirskia intermedia*, Dyb., var. β, and the new species, *L. Tcherskii* and *L. fusifera*. The paper is fully summed up in French. The same number contains a note on *Polyzonium germanicum*, Brandt, by M. Rimsky Korsakoff; a paper, by W. Schimkevitch, on some new species and varieties of *Pantopoda* from the Arctic Ocean (Barents's Sea), in which the new forms *Ammothea borealis*, *Nymphon rubrum*, var. *intermedium*, *Nyphon grossipes*, var. *armatum*, *Tanystylum hœkianum*, *Phoxihilus bœhmii*, are described and figured. The author also gives the plates which are intended to show that the two species, *Phoxihilus vulgaris* and *Ph. charybdæus*, are different. M. Eugéne Schultz describes the new species *Loxosoma harmeri*; and A. Yaschenko gives a catalogue of the fishes in the museum of the St. Petersburg University.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 27.—"A Method for rapidly producing Diphtheria Antitoxines." Preliminary note. By Dr. G. E. Cartwright Wood.

In this preliminary communication[1] a method was described by means of which, firstly, an animal can be rendered immune towards large quantities of diphtheria poison; secondly, such animals can be made to produce powerful diphtheria antitoxines. The distinctive feature of the method consists in the use of the products produced by the growth of the diphtheria bacillus in albuminous fluids made by the addition of serum to ordinary peptone broth. This fluid is, after three or four weeks' growth at 37° C., filtered through a Chamberland candle and heated for an hour at 65° C. This liquid, which is described as "serum" toxine, probably depends for its action on the presence of the diphtheria albumoses described by Sidney Martin. It gives rise on injection to little or no local reaction, but to a marked rise of temperature, which is still more pronounced when the injection is repeated. The ordinary toxine obtained by the growth of the diphtheria bacillus in fresh peptone broth, or in putrid broth (Spronck's method), was also made use of, and this is referred to in the paper as "broth" toxine.

In the first experiment (Horse No. 1) 380 c.c. of serum toxine was injected during the first fourteen days for the purpose of immunising the animal, and thus protecting it against the subsequent introduction of the much more irritating and deadly broth toxine. During the next fortnight it then received 310 c.c. of broth toxine in three injections without being markedly affected, and was then bled at the end of this period. The antitoxic value of the serum was then found to be ten normal units, 1-100th of a c.c. protecting against ten lethal doses of broth toxine, a result obtained by the ordinary method only after ten weeks treatment.

In the second experiment (Horse No. 2), the animal received 1350 c.c. of serum toxine mixed with 51 c.c. of antitoxine during the first fortnight. During the next two weeks it received 950 c.c. of broth toxine mixed with 350 c.c. of serum toxine. When the animal was bled at the end of a month, 1/1000th c.c. was found to protect a guinea-pig against ten lethal doses of broth toxine.

In the third experiment (Horse No. 3), the horse received the serum toxine without the addition of antitoxine, and, as will be seen from the following table, the results were even more striking.

	Antitoxic value of serum.		Amount of toxines injected.
7th day ...	$\frac{1}{300}$ c.c.	...	1200 c.c. serum toxine.
14th day ...	$\frac{1}{500}$ c.c.	...	980 c.c. serum toxine.
21st day ...	$\frac{1}{850}$ c.c.	...	650 c.c. serum toxine and 1050 c.c. weak broth toxine.
28th day ...	$\frac{1}{1250}$ c.c.	...	1100 c.c. serum toxine and 1200 c.c. stronger broth toxine.

The high antitoxic value of the serum obtained from horses Nos. 2 and 3 suggested that the serum toxine might be made use of at a later stage, as well as for the purpose of rapidly immunising the animals. When mixed with the ordinary toxine, and injected as usual, although the results obtained were better, they were not so striking as one might have expected. On examining more in detail the protocols of the horses in which the best results had been obtained, it was observed that these had been under more or less continuous treatment with the toxines, both toxines being injected in as large amounts, and as frequently as possible, so that the animal was kept in a chronic condition of local and constitutional reaction. For the purpose of determining whether the favourable result was due to this "cumulative" action of the toxines, four horses, which had been under the ordinary treatment for periods varying from nine months to a year, were treated in the following way. They received one evening each 300 c.c. of serum toxine prepared by Spronck's method, and on the following morning an injection of weak broth toxine, the latter being usually repeated daily during the rest of the week. This treatment was continued during the following week, and the serum then tested for its antitoxic value. The results are seen in the following table.

	Strength of serum before treatment.		Strength of serum after 16 days' treatment.		Amounts of toxines injected during the 16 days.
Horse No. 4 ...	$\frac{1}{600}$ c.c.	...	$\frac{1}{2000}$ c.c.	...	650 c.c. serum toxine and 2350 c.c. weak broth toxine.
Horse No. 5 ...	$\frac{1}{400}$ c.c.	...	$\frac{1}{1500}$ c.c.	...	600 c.c. serum toxine and 1800 c.c. weak broth toxine.
Horse No. 6 ...	$\frac{1}{300}$ c.c.	...	$\frac{1}{750}$ c.c.	...	650 c.c. serum toxine and 2350 c.c. weak broth toxine.
Horse No. 7 ...	$\frac{1}{400}$ c.c.	...	$\frac{1}{750}$ c.c.	...	650 c.c. serum toxine and 2350 c.c. weak broth toxine.

These results indicate clearly that the rapid productions of anti-toxine depended on the increased sensitiveness of the animal, owing to the injections being repeated before the previous ones had had time to pass off. Some preliminary experiments have indicated that this cumulative action may be produced in an even more marked degree by the use of other toxines than those produced by the diphtheria bacillus.

It is claimed for this method that powerful diphtheria antitoxines can be easily produced in a shorter space of time than has hitherto been possible, and that, as a consequence, the amount of serum necessary to be injected is greatly reduced, while its greater strength will permit of the patient receiving at the beginning of treatment a sufficient quantity of the serum at one injection, when, as is universally recognised both by animal experiment and clinical experience, its curative action is exerted most markedly.

March 19.—"On the Relations of Turacin and Turacoporphyrin to the Colouring Matter of the Blood." By Prof. Arthur Gamgee, F.R.S.

In a recent paper read before the Royal Society, the author has shown that the intense absorption band in the extreme violet, which is observed in the spectrum of highly diluted solutions of hæmoglobin and its compounds, is (with slight changes in its position) exhibited by certain of the derivatives of the blood colouring matter, *e.g.* by hæmochromogen and the compounds of hæmatin, and by that remarkably interesting coloured but iron-free derivative of the latter body, hæmatoporphyrin.

Having found that no organic body which he had examined exhibits an absorption band occupying the position, or possessed of the remarkable intensity, of the extreme violet band under discussion, it seemed as if the latter owed its origin to a group of atoms existing in, and perhaps characteristic of, the blood colouring matter, which group remains intact in certain of the products of decomposition of the complex hæmoglobin molecule, whereas it does not exist in certain other of the derivatives of the hæmochromogen or hæmatin moiety of the molecule, such as bilirubin and urobilin. It appeared interesting to determine whether turacin, which, as Prof. Church first showed in 1869,[1] presents two absorption bands in the visible spectrum, which have a remarkable resemblance to those of oxy-hæmoglobin,

[1] The investigation has been carried out in the laboratories of the Royal Colleges of Physicians and Surgeons, and I should like here to express my great indebtedness to the Laboratories Committee for the facilities there afforded to me. I must also thank them and, through them, the Honourable Goldsmiths' Company, from whose Research Fund a grant was placed at my isposal.—G. E. C. W.

[1] A. H. Church, "Researches on Turacin, an Animal Pigment containing Copper," *Roy. Soc. Proc.*, vol. xvii. (1869) p. 436; *Phil. Trans.*, vol. clix. (1869) pp. 627-636.

would exhibit in the extreme violet or the ultra-violet, an absorption band similar to that of the compounds and certain of the derivatives of the blood colouring matter. It was found that solutions of turacin in caustic soda or ammonia, so dilute as to be almost colourless, and to exhibit, when a stratum 10 mm. thick was examined, only a faint shading in the position of the stronger of the two turacin bands in the green, absorbed the extreme violet and ultra-violet rays of the spectrum *precisely as* highly diluted solutions of the acid compounds of hæmatin (*e.g.* hæmatin hydrochloride dissolved in glacial acetic acid). The earlier observations were made by allowing the spectrum of a beam of sunlight reflected into the dark room from the mirror of the heliostat, and which had passed through the solution of turacin, to fall upon a fluorescent screen of the double cyanide of platinum and barium, when an intense absorption band at the commencement of the ultra-violet was visible to the naked eye. This observation was subsequently confirmed by taking a series of photographs of the spectrum, employing solutions of turacin of various degrees of concentration.

It thus appears that turacin, like the acid compounds of hæmatin, exhibits an absorption band, which is exactly on the boundary of the ultra-violet proper, and which extends further and further into the ultra-violet, as the concentration of the solution increases.

The identity of the spectrum of turacin with that of the hæmatin compounds was so complete that it led the author to surmise the existence of a close relationship between the copper-containing body and the iron-containing colouring matter of the blood. Without any knowledge of Prof. Church's second investigation, published in 1892,[1] in making an oral preliminary communication of his first results to the International Physiological Congress at Berne, in September, 1895, the author expressed his conviction that turacin contains the same atomic group which is the cause of the extreme violet and ultra-violet absorption band in the spectrum of highly dilute solutions of hæmoglobin and its derivatives, and predicted that by removing the copper from turacin, it would be possible to obtain a turaco-porphyrin similar to the body (hæmato-porphyrin) which results from the removal of the iron from hæmatin. It was only after the completion of the experiments necessary for the elucidation of this point, that the fact of his having been anticipated in this matter by Prof. Church was brought under the notice of the author.

The results of the present work offer, however, an independent and additional confirmation of Prof. Church's results.

The facts placed on record in this paper point to the essential identity of turaco-porphyrin and hæmatoporphyrin, and when taken in connection with the identity of the ultra-violet spectrum of turacin, and of the acid hæmatin compounds, appear to establish that turacin contains the atomic group, which is the cause of the characteristic extreme violet and ultra-violet absorption exerted by hæmoglobin, its compounds, and principal derivatives.

Entomological Society, April 1.—Prof. Meldola, F.R.S., President, in the chair.—Mr. Champion exhibited, on behalf of Mr. Blatch, specimens of *Quedius riparius*, Kellner, captured in February last on the banks of running streams at Porlock, Somerset. He remarked that the insect was an interesting and unexpected addition to the British list, and the second recent novelty from the west country, the other being *Ochthebius lejolisi*, Muls. and Rey, found at Ilfracombe in June last by Mr. Bennett. He added that Mr. Waterhouse had informed him that he had seen specimens of the Quedius from Wales and Scotland. Mr. Champion also exhibited a small collection of Coleoptera made by Mr. O. V. Aplin in Southern Tunis during various expeditions inland from Gabes. The collection included some interesting Tenebrionidæ of the genera *Pimelia* and *Adesmia*. Mr. Aplin noticed specimens of these insects impaled by shrikes.—Mr. Goss exhibited, for Mr. Cameron, an apterous male of *Mutilla contracta* taken at Barrackpore, India. The specimen was stated to be the first recorded instance in this species of a wingless male, and was also abnormal in having the thorax incised laterally.—Dr. Sharp, F.R.S., called attention to the fact that at a recent meeting of the Society (March 20, 1895) a specimen of a supposed dimorphic form of one of the species of *Dytiscus* was examined, and Prof. Stewart inquired whether any anatomical examination had been made of the sexual organs. He said that in the *Comptes rendus* Soc. Bordeaux, 1894, there was an account of the examination of the sexual organs of the supposed second form of *D. marginalis* by M. Peytoureau, who came to the conclusion that it was really a distinct species.—Prof. Poulton, F.R.S., exhibited examples of the type labels now in use in the Hope Collection at Oxford, and illustrated their employment by projecting on the screen, by the lantern, a photograph of the Westwood types of African *Eusemiæ* described in F. Bates' "Matabele Land" (London, 1881). He said that such labels, having been once set up in type, could be reproduced in electrotype very cheaply and efficiently. Mr. Verrall said he was of opinion that no species should be described from a single type, but from many specimens, and he wished every so-called "type" could be destroyed as soon as a species had been described from it. Mr. Blandford explained the system of labelling types in the Brussels Museum. Dr. Sharp, Prof. Meldola, Mr. McLachlan, and Prof Poulton continued the discussion.—Mr. Blandford exhibited a series of lantern slides showing the uses to which photography could be put in entomological illustration. The photographs shown included various *Saturniidæ*, *Vanessidæ*, species of *Mamestra*, *Tipula*, *Ophion*, *Carabus*, *Lucanus*, *Sitones*, &c., as well as one or two examples of insect-injury, and a view in Windsor Park showing oaks defoliated by *Tortrix viridana*. Prof. Meldola expressed surprise that photography had hitherto been so little employed in the illustration of works on entomology.—Prof. Poulton read a paper entitled "On the Courtship of certain European Acridiidæ." He said that these observations upon the courtship of Swiss Acridiidæ were made in exceedingly favourable weather at the end of August and beginning of September last year. He was much indebted to Mr. F. Jenkinson and Mr. V. F. Dickins for many independent observations and valuable confirmation. The observations were almost all made in the neighbourhood of the Weisshorn Hotel, high above Vissoye, in the Val d'Anniviers. Prof. Meldola expressed great interest in the paper, and said that the observation of the habits of insects in the field seemed to be much neglected by many entomologists. Dr. Sharp remarked that there was a greater variety in the organs capable of producing sound in the Orthoptera than was generally supposed.—Mr. G. F. Hampson read a paper entitled "On the Classification of Three Subfamilies of Moths of the Family Pyralidæ: the *Epipaschiinæ*, *Endotrichinæ*, and *Pyralinæ*."

PARIS.

Academy of Sciences, April 7.—M. A. Cornu in the chair.—Applications of the theory of divergent series capable of summation, by M. E. Borel.—Some remarks on the X-rays, by S. P. Thompson. An account of the phenomena observed with a fluorescent screen in a Crookes' tube during the gradual production of a vacuum. At a very high vacuum, the rays penetrate bones as well as flesh, and hence there is a certain degree of exhaustion for which the difference between the transparency of the bone and flesh is a maximum.—On electrified Röntgen rays, by M. A. Lafay.—A condition for the maximum power of Crookes' tubes, by MM. J. Chappuis and E. Nugues. The radiation of a Crookes' tube, as measured by the rate at which its rays discharged an electrometer, was found to vary with the rate of vibration of the commutator of the Ruhmkorff coil employed. For the coil used by the authors, ten breaks per second produced the maximum effect; rates higher or lower than this were less effective.—Thermal studies of some oxybromides, by M. Tassilly. Determinations of the heats of solution of the hydrated oxybromides of the alkaline earths.—Action of hydrobromic and hydriodic acids upon phosphoryl trichloride, by M. A. Besson.—At a temperature of 400°–500° in presence of pumice, hydrobromic acid acts upon phosphoryl trichloride giving the complete set of substitution derivatives $POCl_2Br$, $POClBr_2$, $POBr_3$, and PBr_5. Hydriodic acid acts somewhat differently, a solution of the gas in phosphoryl trichloride slowly reacting at the ordinary temperature giving phosphorus triiodide and metaphosphoric acid.—On a sample of rice over a century old, by M. Balland. The sample on analysis differed from ordinary rice only in a lower percentage of fat.—Elongation of the lower limbs due to castration, by M. Lortet.

BERLIN.

Meteorological Society, March 3.—Prof. Börnstein, President, in the chair.—Prof. Hellmann spoke on Indo-Germanic superstitions as to weather, which are still widespread among the people, and are based upon a belief in the importance of the twelve days from Christmas to Epiphany, or

[1] A. H. Church, "Researches on Turacin, an Animal Pigment containing Copper," *Phil. Trans.*, vol. 183 (1892), A, pp. 511-530.

from January 1 to 12, as determining the weather forecasts for the whole ensuing year. These rules are contained in a work, "Die Bauernpraktik," of which the first German edition appeared in 1508, and having attained a wide circulation over western and northern Europe, was translated into English, French, Danish, Swedish and Bohemian, and passed through numberless editions in the sixteenth and seventeenth centuries. There is no known author of this work, but the speaker had succeeded in tracing out manuscripts of the thirteenth century, and the writings of the Venerable Bede in the ninth, as the source of the book. From Bede's writings—which deal not only with weather forecasts, but contain also a "Thunder-book," which is still popular in Sweden—it is evident that the author had translated a Greek manuscript. Certain passages in Pliny refer to Democritus as the source of some of the forecasts, and of the significance of the twelve days mentioned above. But the superstition as to these days is of still older date, for statements which, although incomplete, are, on the whole, similar to those in the "Bauernpraktik," are found on the Babylonian tablets, and the speaker hence concluded that the superstition is of Babylonian origin.

Physiological Society, March 6.—Prof. du Bois Reymond, President, in the chair.—Prof. Zuntz read a communication by Messrs. Asher and Lüscher, in Bern, in which they describe the first results of an investigation of the electrical changes in the œsophagus during deglutition. Using german-silver wire electrodes and a capillary electrometer, they observed a movement of the mercury whenever a wave of contraction passed over the portion of the œsophagus included between the electrodes.—Dr. Rothmann spoke on secondary degenerations of the pyramidal tracts resulting from unilateral extirpation of the cortical centres for the extremities.—Prof. Zuntz spoke on the results of his investigations on metabolism, which had shown that the performance of 1 kgm. of work requires the consumption of 28 kgm. of chemically equivalent energy, whether it be derived from proteids, from fats, or from carbohydrates. Chauveau had recently come to the conclusion, based on experiments, that sugar alone is used up in a muscle doing work, and that when the animal is fed with fat the latter is preliminarily changed into sugar by the liver. The speaker showed that this assumption involves the occurrence of a very complicated chemical process, during which a large part of the energy of the food must be set free in the liver and remain unused. Chauveau had also stated that the same amount of energy is used up in positive as in negative work, and against this view the speaker advanced the results stated above for positive work, while, on the other hand, during the negative work of descending an incline with the lesser declivity, less chemical energy is consumed, thus corresponding to the lessened work. As the declivity becomes gradually greater, the amount of chemical energy increases, at a certain stage is equal to the work done, and then increases rapidly beyond the ratio given above for positive work.—Dr. Rawitz reported on an investigation of the well-known statement made by Darwin that imperfect albinos—animals with white hides and blue eyes—are deaf. Having become possessed of a white dog with blue eyes, he had found, by experiments lasting over three weeks, that this dog really was deaf. After killing the dog, he found that the cortical auditory centres of both sides were atrophied, being on one side reduced to half the normal amount, and on the other to one-third. The cochlea of the inner ear was also wasted away, and the auditory ossicles ankylosed.

March 20.—Prof. du Bois Reymond, President, in the chair.—Dr. René du Bois Reymond discussed Stieda's theory of the homology of the limbs, in detail with reference to the bones and muscles, and briefly as to the blood-vessels and nerves.—Dr. Epstein demonstrated a new turbine, a new perimeter, and a new kymograph constructed for the purpose of experimenting on the influence of colour-perception on blood-pressure.—Prof. Thierfelder reported on two further experiments, made in conjunction with Dr. Nuttall, on animals free from bacteria. In one of these, two guinea-pigs were fed for thirteen days, in the other for ten days, aseptically with milk and biscuit. The animals remained in every respect normal, and gained in weight to the same extent as others fed with ordinary milk and biscuit. Their urine contained ethereal sulphates, although the alimentary canal was free from bacteria.

Note.—In the report of the Physiological Society on p. 503 of Nature, column 2, line 37 from the top, for "height of circulation" read "height of contraction."

Philadelphia.

Academy of Natural Sciences, March 10.—A paper entitled "Summary of New Liberian Polydesmoidea," by O. F. Cook, was presented for publication.—General Isaac J. Wistar made a communication on the apparent capricious distribution of iron oxide as colouring matter in the rocks of the anthracite coal region. At several points, apparently, the accessible supply of iron was exhausted by complete distribution in the strata under process of deposit with intermediate and subsequent periods during which new supplies appear from some source not yet clearly explained. Prof. A. P. Brown stated that it had been suggested by Russell that the red colour of certain formations may have originated from the subaërial decay of iron-bearing rocks, and the subsequent deposit of this material as sediment forming the red rock. As far as the ash of coal is concerned, it is probable that the colour is due to the way in which pyrites is contained either in the coal itself or in the slate adjoining. Coal containing separable pyrites would give white ash, while if the pyrites is intimately mixed in the coal the ash will be red.—Mr. James Willcox and Prof. Angelo Heilprin commented on the evolutionary value of the large collection of fulgurs presented to the last meeting, the former claiming that about twenty-five species had been reduced by the presence of complete series of intermediate forms to three or four.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Heart of a Continent: Captain F. E. Younghusband, 2nd edition (Murray).—Argon and Newton: Lieut.-Colonel W. Sedgwick (Whittingham).—British Sea Birds: C. Dixon (Bliss).—Les Rayons X: Dr. C. E. Guillaume (Paris, Gauthier-Villars).—Report of the Commissioner of Education for the Year 1892-93, Vol. 2 (Washington).—Queen's College, Galway, Calendar for 1895-96 (Dublin, Ponsonby).

Pamphlets.—Prof. Röntgen's "X" Rays, and their Applications in the New Photography (Glasgow, Bauermeister).—Die Denkschöpfung, &c.: A. Bastian (Berlin, Dümmlers).—The Magnetic Circuit: Dr. H. du Bois, translated by Dr. Atkinson (Longmans).

Serials.—Journal of the Royal Statistical Society, March (Stanford).—Engineering Magazine, April (Tucker).—Journal of the Franklin Institute, April (Philadelphia).—Science Progress, April (Scientific Press).—Imperial University, College of Agriculture, Bulletin Vol. ii. No. 6 (Tōkyō).—Studies from the Yale Psychological Laboratory, Vol. 3, 1895 (New Haven).—Ethnologisches Notizblatt, Heft 3 (Berlin, Haack).—American Journal of Science, April (New Haven).—American Naturalist, April (Philadelphia).—Strand Magazine, April (Newnes).

CONTENTS.

THURSDAY, APRIL 23, 1896.

A NEW BOOK ON MAN.

Ethnology. By A. H. Keane. "Cambridge Geographical Series." Pp. xxx + 442. (Cambridge: University Press, 1896.)

A HANDY but comprehensive work on ethnology has long been required alike by the student and general reader, and it is with pleasure and interest that we welcome the appearance of a book which is claimed by the author to be a synthesis and a trustworthy guide.

Mr. Keane's book is divided into two parts: (1) Fundamental Ethnical Problems; and (2) The Primary Ethnical Groups. After a definition of terms, which is rather unsatisfactory, as is also the title of the book itself, the author deals with the physical evolution of man, and here as elsewhere the evolution doctrine is accepted. In this chapter, there is the inevitable phylogenetic tree; but in this instance it is furnished with a bunch of unexplained roots. Whatever truth this scheme may illustrate, we fail to see the conclusion that "from this diagram it is made evident that the ascent of the Hominidæ is in an independent line from some long extinct generalised form," &c. When will people learn that a phylogenetic tree does not *prove* anything! The treatment of the mental evolution of man in a short chapter is somewhat inadequate for that most important subject. The antiquity of man is dealt with in various chapters; in the prefatory general considerations, "Croll's last two glacial epochs" are "accepted in all their fulness," and the author decides in favour of interglacial man, who "specialised not less, probably much more, than half-a-million years ago." The chapters on Palæolithic and Neolithic man are useful summaries, but with several questionable statements. Geographers will scarcely admit that "the explanation," of the attractiveness of Denmark to Neolithic men, "lies in the physical and biological conditions of a region washed by the warm waters of the Gulf Stream." The argument for the specific unity of man will prove of service to many readers. It is strange that, though the meaning of the terms genus, species, and variety "is clearly defined in a way that gives rise to no misunderstandings," Mr. Keane attributes to Linnæus the erection of "four species" of the group *Homo sapiens* (p. 164), whereas these were evidently regarded as varieties of that species by the great Swedish naturalist. On p. 25 we find a paragraph commencing thus: "HOMINIDÆ. (Linné's Genus *Homo*), with no specific divisions, but four primary varieties"—a system of nomenclature that no biologist would recognise. Somehow or other, in spite of his statement that the meaning of the terms species, &c., is so fixed as to give rise to no misunderstanding, the author does not appreciate the rules for zoological nomenclature; apparently his view is that the single species of *Homo* differentiated in early times into four varieties, which he calls *Homo Æthiopicus*, *Homo Mongolicus*, *Homo Americanus*, and *Homo Caucasicus*, so that we now have four varieties in the genus, but no species.

In the chapter on the physical criteria of race, Mr. Keane gives an account of the data utilised in classifying the different groups of man, and a selection of the various systems of classification that have been adopted; the ingenious system of Deniker deserves a more detailed description than is accorded to it. The remarkable statement on p. 171, that the greater abundance of pigment in the skin of the negro "seems due to the stimulating action of the solar heat combined with moisture and an excess of vegetable food, yielding more carbon than can be completely assimilated, the character being then fixed by heredity," must not pass unchallenged. It is true that Waitz adduces many examples to show that "hot and damp countries favour the darkening of the skin," and though this may be a factor, there are too many exceptions for it to be a sufficient cause; evidently this has also struck the author, but the fixation of black carbon through an excess of vegetable food is a theory that is decidedly comical, though it is doubtless offered in good faith. Mr. Keane devotes nearly the whole of the section on the mental criteria of race to a disquisition on the evolution of language. He asserts that monosyllabism is not the first but the last stage in the growth of a language; if this be true, then the German language must be in its infancy. Several of his views on linguistic evolution are, to say the least of it, heterodox, and will probably lead to further discussion.

The second part, which deals with the main divisions of mankind, is a most useful summary of a vast range of reading, and will prove of great utility to all interested in the subject, although there are many statements which will not approve themselves to every specialist. Mr. Keane argues in favour of the evolution of the pliocene precursor of man in the Indo-African Continent, which has replaced Sclater's Lemuria. This continent extended from South India to Africa and Madagascar, including the intermediate islands, and also was in biological relation to the hypothetical Austral Continent, which extended from New Guinea and Tasmania to the islets of St. Paul and Amsterdam. "Thus when the pliocene precursor, wherever evolved, began to spread abroad, he was free to move in all directions over the eastern hemisphere."

One or two examples will illustrate Mr. Keane's views on certain problems. Besides the Negritoes who extended along Malaysia to New Guinea, there was a primitive population of Melanesian Papuans, who also spread over the whole of Oceania as far as Hawaii, Easter Island, and New Zealand. These were also the aborigines of Australia, who thence passed over into Tasmania; Australia also received a contingent of "Caucasian Melanochroi" (*i.e.* the Dravidian element in Australian ethnology), and also a Malay infusion, "while the Neanderthal characters persisting here and there would be traceable to the *Ur-Einwanderung* of the pliocene precursor from the Indo-Austral Continent."

"The Melanesian language [which Dr. Codrington has shown to be the most primitive existing form of the Malay-Polynesian group] is not indigenous in its present home, but must have been introduced and imposed upon the Papuan natives by some foreign people in remote prehistoric times. This people is none other than the Eastern Polynesians, a branch of the Caucasic division, who possibly in the Neolithic period migrated from the Asiatic mainland to Malaysia and thence eastwards to the remotest islands of the Pacific Ocean."

Mr. Keane, as we have seen, is not particularly happy

when attempting to explain the effect of environment on man, as the following extract will also prove.

"It has been shown that the precursor was most probably furry, with a woolly under and a sleek outer coat, and it is conceivable that in a volcanic environment like that of Java, it might have been advantageous to shed the wool and retain the sleek hair, together with all the other physical characters of the primitive Negrito."

The white race (*Homo Caucasicus*, as Mr. Keane delights to term it) is held by the author to have evolved in, and dispersed from, North Africa; but he strangely omits to refer to Dr. D. G. Brinton, who, in his "Races and Peoples" (1890), had already promulgated that view.

It is evident that Mr. Keane is a very diligent and widely-read literary man, but he is decidedly weak on the scientific aspects of his subject. Lastly we must criticise those figures which were copied from the author's "Types of the Races of Mankind," in Longmans' New Atlas. The process-blocks from these lithographs have a very coarse appearance, and offer a marked contrast to those taken from photographs. On the whole, the selection of the illustrations of racial types is well made.

Although there is a good deal of what may be termed contentious matter, besides numerous errors, in Mr. Keane's book, we can recommend it as a most useful introduction to a very complicated study; and as the author has brought together and abstracted a large number of references, the student can use the book as a point of departure, and thus it will serve as a base for a more extended or detailed survey of this really important branch of science. A. C. HADDON.

RIGID DYNAMICS.

An Elementary Treatise on Rigid Dynamics. By W. J Loudon, B.A., Demonstrator in Physics in the University of Toronto. Demy 8vo, pp. ix + 236. (London: Macmillan and Co., 1896.)

THERE are few mathematicians who do not vividly recollect the difficulties they experienced when reading "Rigid Dynamics" for the first time. Mr. Loudon's treatise does much to smooth away these difficulties; and if it still leaves undone much that might have been done in simplifying the subject for beginners, it nevertheless fills a gap the existence of which has long been felt among teachers.

From a purely mathematical standpoint, we have none but praise to offer. As a digest of the earlier matter of Dr. Routh's treatise up to, but not including, Lagrange's generalised equations of motion, it will be welcomed by all students whose primary object is to master the equations of motion of a rigid body without diving too far into higher applications.

The order of treatment is essentially based on "Routh," with the exception that Mr. Loudon gives no separate chapters on "Motion in Two Dimensions," "Momentum," and "Vis Viva." Thus the first two chapters deal with "Moments of Inertia" and "Ellipsoids of Inertia," and are followed by chapters on "D'Alembert's Principle" and on "Motion about a Fixed Axis." After the latter problem has been considered both for finite and "impulsive" forces, the same is done for motion about a fixed point. In this connection, the equations of motion of a top, and of a body moving under no forces, are discussed as far as they can adequately be treated without using elliptic functions. The book concludes with a chapter on the "Gyroscope," in which the experimental proof of the earth's rotation is figured and described at some length.

One very commendable feature is the large number of diagrams. To represent on paper three planes at right angles in a rigid body is a task which previous writers have shirked; but Mr. Loudon's large and bold figures will do much to assist the reader in forming a concrete idea of the motions he is dealing with. We might instance more especially Fig. 50, illustrating the motion of a top spinning on a horizontal plane, and Fig. 58, illustrating how the motion of a rigid body under no forces is completely represented by the rolling of the momental ellipsoid on a fixed plane.

To our mind the book's chief drawback, considered as an *elementary* treatise, lies in the author having, no doubt unconsciously, followed Dr. Routh's analytical methods too closely instead of striking out in simpler lines of treatment. That it is a useful exercise to start every problem by writing down the fundamental equations

$$\Sigma m\frac{d^2x}{dt^2} = X, \quad \Sigma m\left(y\frac{d^2z}{dt^2} - z\frac{d^2y}{dt^2}\right) = L$$

cannot be doubted, but the ordinary beginner often finds it hard to proceed from these equations to the final solution. What he now chiefly requires is a thorough grasp of the nature and significance of "angular momentum." We by no means wish to overrate the educational value of the familiar type of Tripos rider, whose solution merely involves writing down the equations of conservation of angular momentum and energy, and eliminating between the two; at the same time, we do think that much may be learnt from problems of this class, especially by the beginner. For a similar reason we are sorry not to find "Motion in Two Dimensions" treated earlier. Again, in deducing Euler's equations of motion, it seems a pity that the author has adopted Dr. Routh's laborious proof, a proof which is always found very hard to grasp. Its difficulty is largely due to the necessity of proving the relation

$$\frac{d\omega_1}{dt} = \frac{d\omega_x}{dt}$$

connecting the rates of change of the angular velocities about fixed and moving axes respectively. The author gives two proofs of this identity, occupying four pages of difficult mathematics; but the result is, after all, only a particular case of the general property of moving axes, which, when applied to any *other* vector quantity (angular momentum, for example), assumes the far more intelligible and suggestive form

$$\frac{dh_x}{dt} = \frac{dh_1}{dt} - h_2\omega_3 + h_3\omega_2$$

and thus leads to a far shorter proof of Euler's equations.

In a few respects the book slightly lacks in finish. A tyro might easily complete the chapter on "D'Alembert's Principle" without having his attention drawn to what that principle really is, or might even mislead himself into the impression that the principle consisted in the mere equations

$$\Sigma(f_1) = \Sigma(f_2) = \Sigma(f_3) = 0.$$

Again, on p. 127, the author commences to explain the "sleeping" of a top, but stops short after briefly indicating that the effect is due to friction. It would require considerable mathematical ability to prove the phenomenon by actually integrating the equations of motion, taking account of friction in the manner suggested.

Most people find it easier and quite as effectual to explain the observed results from general principles.

Such difficulties would mostly disappear in the hands of an accomplished teacher. Moreover, the volume is exceedingly rich in examples, both illustrative and otherwise, and, in addition to those contained in the text, there is a collection of 300 problems at the end. As a class-book, or for use in the lecture-room, Mr. Loudon's treatise may therefore be safely recommended. G. H. B.

OUR BOOK SHELF.

Our Country's Butterflies and Moths, and how to know them. A Guide to the Lepidoptera of Great Britain. By W. J. Gordon, author of "Our Country's Birds," "Our Country's Flowers," &c. With a thousand examples in colour by H. Lynn, and many original diagrams. Crown 8vo, pp. vii + 150, plates 32. (London: Day and Son, 1896.)

ONE remarkable circumstance noticeable in the present plethora of works on British butterflies and moths, is that almost every new one is composed on a different plan. The present book reminds us a little of Wood's "Index Entomologicus," except that the figures are not reduced; and it will be very useful to schoolboys commencing a collection. All the *Macro-Lepidoptera* are figured, to the *Geometridæ* inclusive, and all the genera of *Micro-Lepidoptera*, except in the *Tineæ*, where the selection is limited to typical specimens of each family. The execution, though unequal, is fairly good on the whole, and most of the species figured will be easily recognised, though the want of figures of undersides, and of both sexes in the butterflies will be severely felt in many cases. One or two of the figures are, however, so unlike the insects they are supposed to represent, that our first impression on opening the book was that they were intended to represent some foreign species. We may specially instance the figure of *Sphinx pinastri* on plate 7, while that of *Smerinthus populi* is not much better. But this matters less in the case of conspicuous and easily identified species; and where accuracy is really needed, as in the smaller *Geometridæ*, the execution is much better. The letter-press largely consists of indices and tables, and contains much useful information relating to *Lepidoptera*, and even to insects in general. The main characteristics of the families, genera and species are briefly noticed, as well as their sizes and times of appearance, but nothing is said about localities or comparative rarity. Notices of the larvæ are limited to those of the butterflies; English as well as Latin names are used throughout. It is only fair to the author to say that we have rarely seen a book in which so much information was compressed into so small a space.

Handbook for the Bio-Chemical Laboratory. By Prof. John A. Mandel. Pp. 101. (New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1896.)

IN this handbook will be found detailed descriptions of the methods of preparation of the most important substances which enter into the composition of the fluids and tissues of the animal body, and a synopsis of the tests for such substances, arranged in alphabetical order. Students of physiological chemistry will find the volume a handy laboratory manual.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Buried Celluloid.

IT has occurred to many people, that perhaps celluloid migh be useful as an insulator for electric cables. I feared it migh deteriorate. I have made an experiment of 4½ years duration which may be of use in connection with the subject. On August 15, 1891, I took four photographic quarter-plate celluloid plates, with the gelatine removed, and treated them as follows:—

No. 1 was nailed to an outhouse, and became rotten in a year.
No. 2 was 1 foot deep in garden soil.
No. 3, 1 foot deep in gravel.
No. 4, 1 foot deep in a rubbish heap.

The last three were dug up on April 6, 1896. Nos. 2 and 4 were in as perfect condition as ever. No. 3 has some sand rubbed in, but is perfectly sound.

The experiment was made at Pitlochry, N.B. The specimens can be seen at my office. GEORGE FORBES.

34 Great George Street, Westminster, S.W., April 16.

Suggested Photography by Transmitted Heat Rays.

I AM no chemist, and may be mistaken, and what I propose would be more curious than useful; but I believe it would be possible to get a visible shadow of a small object which was concealed from sight by being enclosed within an opaque material. There are substances opaque to light, but which transmit the rays of heat; most readily, I suppose, those from the sun, and these are substances on which such heat rays inpinging would cause some visible change.

If the heat-transmitting substance allows the rays to pass without dispersion, preserving their rectilinear direction, then these rays falling upon a duly prepared screen would cause a visible change upon a portion of its surface; and any ordinary opaque object placed within the heat-transmitting substance would cast a shadow, dark, or bright, as the case may be.

Penzance. REGINALD COURTENAY.

Influence of Terrestrial Disturbances on the Growth of Trees.

As the subject of forestry has recently been much under discussion, and appears to be exciting more interest in this country than it was, I trust I shall not be trespassing upon your space in calling attention to a peculiar case of timber growth which I have noticed, and in soliciting the opinions of those of your readers who are likely to be well-informed upon foreign woods, as to its true cause.

There is in the British Museum of Natural History the cross-section of a large Douglas fir grown in British Columbia, and stated to be more than 500 years old at the time it was felled, which was, I believe, in 1885. An attractive feature in the section is that the annual rings have been marked off chronologically, and some historical event, contemporaneous with the growth of the ring to which the date is attached, is given.

A glance, however, at one part of the surface of the wood, which is polished, reveals a very remarkable modification of the annual rings, which appears to have taken place towards the close of the first century of the tree's existence. About twenty of the rings are there crowded so closely together as to present, at a short distance, the appearance of a zone about three-quarters of an inch wide running round the trunk, and differently coloured from the rest of the wood. It is also to be particularly observed that the change to ordinary growth on either side of the zone is abrupt; and, further, that no such phenomenon is afterwards presented during the many centuries of the tree's subsequent development.

The suddenness of the changes puts out of court the idea that the check to growth might have been due to overcrowding in the forest during the period of the struggle for supremacy over its fellows, which the tree would undergo, because any effect from this cause would only come on gradually, and diminish in the same manner.

The supposition that twenty bad seasons occurred in succession, is unlikely under any climatic conditions with which we are

familiar. It is true that two or three rings of growth in a tree are often very close together in consequence, perhaps, of adverse seasons, or insect depredations upon the leaves; and this is easy to understand.

It seems therefore not easy to say what can have occasioned this apparently abrupt cessation of vigour in a tree which had previously made good progress, and which again as suddenly renewed its former healthy condition.

Would any extraordinary convulsion of nature be likely to account for the facts of the case? But might we not expect to see evidence of similar catastrophes at various epochs in a tree of such great age? Nothing, however, afterwards appears but ordinary average growth, becoming gradually less with increasing age.

Now the dates given on the part of the section about where the thinning occurs run up comparatively close to, but do not quite correspond with a very remarkable period of the world's history, viz. towards the middle of the fourteenth century. If the tree had ceased to grow for a few years before it was cut, the correspondence would be very close indeed.

About this period many extraordinary particulars are given in Hecker's "Epidemics of the Middle Ages." In this work details occur of the appalling convulsions, terrestrial and atmospheric, to which the world was subjected for some years prior to the outbreak of the Black Death.

Amongst others of a similar tendency the following passages appear.

"Mighty revolutions in the organism of the earth of which we have credible information had preceded it (the Black Death). From China to the Atlantic the foundations of the earth were shaken; throughout Asia and Europe the atmosphere was in commotion, and endangered by its baneful influence both vegetable and animal life."

"Before the earthquake (that of Cyprus) a pestiferous wind spread so poisonous an odour that many were overpowered by it, and expired in dreadful agonies. This phenomenon is one of the rarest that has been observed, for nothing is more constant than the composition of the air."

"Earthquakes were more general than had been within the range of history. In thousands of places chasms were formed from whence arose noxious vapours."

"It is probable, therefore, that the atmosphere contained foreign and sensibly perceptible admixtures to a great extent, which at least in the lower regions could not be decomposed and rendered ineffective by separation."

"The order of the seasons seemed to be reversed—rains, floods, and failures in crops were so general that few places were exempt from them."

"In the inmost depths of the globe that impulse was given in the year 1333, which in uninterrupted succession for six-and-twenty years shook the surface of the earth even to the western shores of Europe. From the very beginning the air partook of the terrestrial concussion. Atmospherical waters overflowed the land, or its plants and animals perished under the scorching heat." (Hecker's "Epidemics of the Middle Ages," trans. Babington.)

Particular mention is made of the fearful natural calamities then visited upon China, which seems to have suffered more than any other place recorded. Now this points to the special activity of subterranean forces on the Pacific sea-board; and, consequently, British Columbia is not unlikely to have come in for a heavy share of the physical disturbances of that period. If so, is it not very probable that as strong an impression would be made upon the plants and animals of that part of the globe as upon those of other countries that are mentioned? Now trees are the only beings at present living which could possibly have been contemporary with these calamities; and, as it is not difficult to determine their age approximately, it would be very interesting to carry out investigations in other instances, and thus ascertain if nature has recorded in the giants of the forest some impress of events which were fraught with such dire consequences to the human race. HENRY J. COLBOURN.

Woolhampton, Reading, April 4.

Carib Pottery.

LAST year in St. Kitts, in a cliff fresh cut by a wash, a gentleman found what were apparently the contents of a Carib grave—fragments of pottery, two complete utensils, and pieces of human bones. The whole is now in the possession of Dr. W. J. Branch.

This is the first discovery, as far as I can ascertain, of either bones or pottery in the Leeward Islands, though Carib pottery is common in some of the Windward Islands. Since then, however, I have found a kitchen-midden, and procured plenty of small fragments, along with crab-claws, broken shells, fish-bones, &c.

The human bones above mentioned are the shafts, without the ends, of a femur, tibia, and fibula, a fifth metatarsal, a phalanx of the thumb, and several chips of the other fibula and

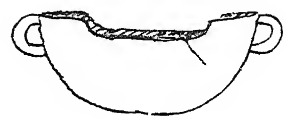


FIG. 1.

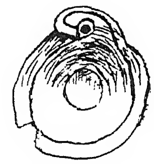


FIG. 2.

tibia. The tibia is curious as being very flat—almost two-sided, the interosseous border being merely a ridge on the outer surface.

The pottery consists of an oval bowl (Fig. 1), which the finder unhappily broke, a small plate (Fig. 2), and a number of fragments. The bowl is mended so as to be now entire; it measures 9¼ in. by 6 in. and 3¾ in. in depth; and was probably made in St. Kitts, where there is no good clay, for it is of a coarse dark earth, soft and badly baked. The plate, size 8 in. by 7 in., is nearly complete; it is of the same material, and is ornamented with an

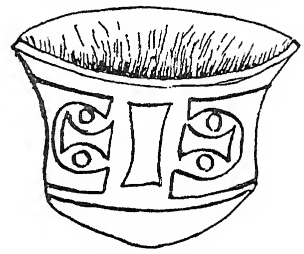


FIG. 3.

incised line winding round and ending in the curious spirally curved handle; there is a small perforated knob on the outside opposite the handle, apparently for a string to hang up the vessel. About fourteen of the fragments have been pieced together, making part of a large jar. From this I have restored the jar as in the sketch (Fig. 3). The dimensions were:—Diameter at brim 13¼ in., diameter at bulge 10½ in., depth 12½ in. It is of the red Nevis clay, apparently turned on a lathe, and well baked. The pattern is in white lines, and fired.

St. Kitts, W. I., March 30. C. W. BRANCH.

The New Education Bill and Local Museums.

I DESIRE to call the immediate attention of those solicitous for the progress and improvement of local museums to the opportunity afforded by the Education Bill now before Parliament for obtaining some public recognition of their value in any scheme for the encouragement of secondary education. By some County Councils the Technical Instruction Act has been construed as permitting grants being made from the "Customs and Excise" funds to local museums, but other Councils have not so acted, and it is very desirable that this point should be definitely settled. All that would be required is the insertion in Section 12 (page 8 of the Bill as printed), and perhaps best at the end of Clause 2, of words giving power to the "Education Authority" to aid in the establishment and maintenance of museums, whether the property of a public body or a private society, provided that such museums are devoted to the instruction of the public, and are, of course, under such regulations and control as might be deemed necessary.

There can be little doubt, I think, of the valuable services which well-arranged local museums could afford to the work of technical instruction, more particularly in calling forth and encouraging a taste for natural science studies. But the great

need of most of these small museums is an adequate and settled annual income sufficient to defray the cost of intelligent management. Capital sums for building, fittings, &c., would flow in, and donations of good local collections would often be made, if the fear of "want of permanence" could be allayed. It is this which is the difficulty in the management of local museums in the vast majority of cases, and a moderate grant of "technical instruction" funds in a county would often give far better results, educationally considered, than many of the objects to which this money is now applied.

The matter is by no means political or controversial—such grants would benefit many deserving institutions; and I hope that all well-wishers of museums will use their influence to get such a clause as that above indicated inserted in the Bill when before Committee. I commend the subject to the Museums Association and to the Secretaries of local scientific societies as one in which their energies would be most usefully exercised.

C.

A Bright Meteor.

We had the good fortune to witness a splendid meteor here on Sunday evening, the 12th of this month. The sky was perfectly clear, the hour 8 p.m. The lady with whom I was walking, by an exclamation called my attention to it, so that I did not see it on its first appearance, but it must have started from the neighbourhood of α Draconis; it then pursued a south-easterly course, passing nearly parallel to ζ and η Ursæ Majoris and α Böotis or Arcturus, and disappearing at last behind a hill to the east. We did not, therefore, see its termination; but I hear from others who did, that there was no explosion. It must have taken several seconds in its flight, as there was time for my companion to make several remarks. Its size was very considerable, and its light intermittent. Three or four times it seemed as if about to be extinguished, but again blazed forth; the colour was a fine yellow, changing to crimson; a train of sparks followed it of about 5° in length. The whole path traversed could not have been less than 50°. In the evening twilight not many stars were visible, so that I was unable to determine its exact course as accurately as I could have wished.

J. D. La Touche.

Stokesay Vicarage, Craven Arms, Shropshire, April 14.

It may be of interest to record the appearance of a fine meteor, the finest I remember to have seen, on the evening of Sunday, April 12, about 8.6 p.m. I was standing in a field in the parish of Mathon, on the extreme western border of Worcestershire, when a friend who was with me drew my attention to it. The meteor was then about 20° E. of N., and roughly half-way between horizon and zenith. It passed downwards and eastwards, very slowly as it seemed to us, till it reached a spot about 30° N. of E., and perhaps 20° above the horizon, when it disappeared. Its course was right underneath the Bear, which, lying east of the pole-star, was just becoming visible at the time. The time during which we watched the meteor I should estimate at from 10 to 15 seconds. The meteor consisted of a bright head appearing many times as large as Jupiter, and a train like a rocket's, but much shorter in proportion. The night, in the intervals of fierce north-westerly squalls, was exceptionally fine and clear.

West Malvern, April 16. A. G. Tansley.

A Daylight Meteor.

At 7.25 a.m., April 18, a meteor was observed by an inmate of my house. The sun was shining clearly in an almost unclouded sky when, in looking up, three bright stars were seen in rapid succession shooting over the trees in a northerly direction. The person who made the observation was much excited with the sight, never having witnessed fire-balls of such brightness and rapidity before.

James Shaw.

Tynron, Dumfriesshire.

"Rana esculenta" in Kincardineshire.

When on a brief visit to Kincardineshire last month, I was surprised to find *R. esculenta* in considerable numbers at a few places which I visited. I found the frogs in pools beside the Bervie, and also in places several miles away. One of these was a small isolated bog. Mr. George Sim, of Aberdeen, who is well acquainted with the fauna of Kincardineshire, was unaware of the existence of this frog in the county until I called his attention to it. In 1837 and 1842 large numbers of these animals were introduced into England, but I have not heard of a similar introduction into Scotland. It does not seem probable that the frog should itself have migrated so far north. When a thorough examination of the district has been made, it may be found that the animal is widely distributed.

Philip J. White.

University College of North Wales, Bangor.

THE RÖNTGEN RAYS.

The investigations of M. Henri Becquerel on the radiation emitted by certain salts of uranium have shown the existence of a kind of radiation intermediate in its properties between light and the Röntgen rays. These investigations are exceedingly interesting on account of the differences as well as the analogies they disclose between the uranium radiation and the Röntgen rays. M. Becquerel has shown that the radiation from the double sulphate of uranyle and potassium is analogous to Röntgen rays, inasmuch as it can affect a photographic plate after penetrating substances such as aluminium, copper, wood, &c., which are opaque to ordinary light; it also resembles these rays in being able to discharge an electrified body, whether the charge be positive or negative. On the other hand, it differs from Röntgen rays and resembles ordinary light, inasmuch as it can be refracted and polarised. It is also much more easily reflected than Röntgen rays. The radiation from the uranium salts is thus intermediate in properties between ordinary light and Röntgen rays; and as there can be no question but that this radiation consists of transverse vibrations, inasmuch as it can be polarised, it affords strong presumptive evidence that the Röntgen rays are also due to transverse vibrations.

The persistence of the radiation from the potassium uranyle sulphate is very remarkable. M. Becquerel found that crystals which had been kept in the dark for 160 hours continued to radiate vigorously. This radiation is absorbed almost equally by aluminium and copper, so that it does not show the same dependence upon the atomic weight of the absorbing medium as that of the Röntgen rays; on the other hand, the radiation resembles Röntgen rays in not being homogeneous.

With respect to direct evidence of the Röntgen rays being due to transverse vibrations, such as would be afforded by a difference between the absorption by two plates of tourmaline (1) with their axes parallel, (2) with their axes crossed, the results are somewhat conflicting. On the one hand, Prince Galitzine and M. de Karnojitsky get a greater absorption through two plates of tourmaline when their axes are crossed than when they are parallel; while, on the other hand, M. H. Becquerel, M. Sagnac, and the writer get no appreciable difference between the two cases. It is just possible that as tourmaline is a mineral which varies greatly in chemical composition, those varieties which contain abnormal quantities of the heavier metals may show this effect, whilst in other specimens it may be too small to be appreciable.

A considerable number of experiments have been made to find the part of the tube where the Röntgen rays originate. Perrin, using pin-hole photography, came to the conclusion that they arise at the places where the kathode rays strike against a solid obstacle. Rowland, Carmichael and Briggs, on the other hand, using a very highly exhausted tube with the terminals only one millimetre apart, located the origin of these rays at the extremity of the *anode*. Prince Galitzine and M. de Karnojitsky place the origin inside the tube some millimetres behind the glass. The writer, with the assistance of Mr. McClelland, investigated this point by measuring the rate at which electricity leaks through an air space of fixed length at different distances from the bulb; the Röntgen rays passing through a small hole in a thick plate of metal. The rates of leak were found to vary inversely as the square of the distance from a point, but

the position of this point with respect to the tube varied with the shape and character of the tube used to produce the rays. When the bulb was pear-shaped, with the negative electrode in the narrow part of the tube, the point was near the place where the bulb began to widen out; while with bulbs containing metallic plates to reflect the rays, this origin of the rays was on the metal plate whatever might be the position of the negative electrode. But in no case did the origin of the rays fall on the part of the tube nearest to the air space through which the leakage was measured, though this was the part of the tube which was most brightly phosphorescent. The origin, however, in these experiments was always at a place where some kathode rays struck against a solid obstacle. In these experiments the rays came through a small hole, so that the want of coincidence between the origin of the rays and the part of the tube where the phosphorescence was brightest, could hardly be explained by supposing that the direction of emission of these rays is practically almost confined to the normal to the phosphorescent surface, so that the apparent source of the rays would be the locus of intersection of the normals to this surface.

The results of the various investigations as to the source of the rays seem to show that this is most commonly at a place where some kathode rays strike against a solid obstacle; they also prove that there are regions in the tube where, though many kathode rays are stopped, very few Röntgen rays are produced. The experiment of Rowland previously mentioned, as well as the one by Lord Blythswood, where the rays were produced at the negative terminal of a Wimshurst machine without a bulb at all, suggest that there are other sources of these rays besides places where solids are bombarded by kathode rays. Judging from analogy with the behaviour of an ordinary discharge tube giving a luminous discharge, there seems nothing unreasonable in the idea that these rays may sometimes originate in the gas itself by the splitting up of its molecules under the electric discharge. When the discharge is luminous there is, as Dr. Schuster has pointed out, generally a peculiar spectrum emitted by the negative glow outside the negative dark space; there is thus in this region, under the comparatively feeble electric field which can exist when the discharge is luminous, some process going on which is favourable to the emission of radiation. Now, when the tube is emitting Röntgen rays the dark space reaches to the walls of the tube, and the intensity of the electric field is enormously greater than when the discharge is luminous. (It is most interesting to connect a voltmeter to the terminals of a tube while it is still on the pump, and observe the way the readings go up when the tube is getting into a fit state to emit Röntgen rays.) It would seem likely that under this very intense electric field the gas in the tube would be more thoroughly split up than under the feeble field which accompanies the luminous discharge, and that this finer subdivision of the gas would cause the emission of radiations of much smaller wave-length. It would be interesting to investigate whether the nature of the gas in the bulb has any effect upon the character of the Röntgen rays emitted by it; it would, however, be necessary to use other pumps as well as mercury ones to try this experiment.

The existence of a definite metallic reflection, which is considerable at grazing incidences, has been proved by Dr. Joly; while Lord Blythswood and other experimenters have published accounts of investigations which confirm Röntgen's observation of a copious diffuse return of rays from a solid obstacle. The definite metallic reflection gives us hope of arriving at the wave-lengths of these rays by interference experiments with metallic mirrors inclined at a small angle, though before this experiment can be successfully attempted it will be necessary to study more closely the want of homogeneity in the Röntgen rays, and to devise methods of producing monochromatic rays. From an interference experiment with negative results, M. Sagnac concludes that the Röntgen rays he was using must have had a wave-length less than 4×10^{-8} centimetres.

A very remarkable experiment has been made by M. Lafay, in which effects are produced similar to those which would occur if under certain circumstances the Röntgen rays were absorbed, and rays having the property of being deflected by a magnet emitted. The experiment is as follows: a photograph of a needle is taken through a thin piece of silver-foil; the Röntgen rays, after passing through the foil, traverse a magnetic field. If the foil is not electrified, the magnetic field produces no effect on the position of the shadow of the needle; when, however, the foil is electrified (by a source quite independent of the one used to work the coil), the shadow is deflected when the magnetic field is on, the direction of deflection is reversed when the sign of the electrification of the foil is reversed. Only a preliminary account of this experiment has yet been published, and in this it is not explicitly stated whether or no the width of the shadow cast by the needle is affected by the magnetic field. The point is an important one in the interpretation of this experiment, for the Röntgen rays, falling on the charged silver foil, will discharge its electrification and produce electric currents in the air; these currents, probably in this experiment flowing somewhat in the direction of the rays, would, when they passed through the photographic plate, probably affect it. Now these currents will be deflected by a magnet, the magnet driving some of them on to the part of the photographic plate previously occupied by the shadow of the needle. They would thus encroach on one side of the shadow; they would not, however, affect the other side unless the Röntgen rays were stopped by the charged plate; as though these currents can obliterate a shadow, they could not produce one where the Röntgen rays are present. Thus the effect of the currents would be to cut a piece off the shadow, and the piece would be cut off from one side or the other, according as the silver-foil was positively or negatively electrified. These currents, however, could not, with the presence of the Röntgen rays, explain a simultaneous shifting of both sides of the shadow of the needle.

Röntgen's discovery of the close connection between the absorption of these rays and the atomic weight of the absorber, has been confirmed and extended by many observers. This is a most interesting result, and it may be remarked is what would occur on Prout's hypothesis of the constitution of the elements, if each little primordial atom furnished its quota to the absorption of these rays.

The rate of leakage of electricity through different gases under the influence of these rays has been measured by Mr. McClelland and the writer. We find that in general the rate of leakage increases with the atomic weight of the gas, although there are exceptions to this rule. The rapidity with which electrification leaks through the halogens is very remarkable; it is interesting to find that the gas through which the rate of leak was greatest was mercury vapour, although the ordinary electric discharge only passes through this gas with great difficulty. When leakage takes place between two platinum plates in a gas exposed to these rays, the plates show strong polarisation.

The connection between the rate of leak through a gas and the potential difference is very remarkable. When the potential difference does not exceed two or three volts, the rate of leak is proportional to the potential difference. Then increasing the potential difference, we arrive at a stage where the rate of leak increases more rapidly than the potential difference. Increasing still further the potential difference, we soon arrive at a stage where the

rate of leak is almost independent of the potential difference. Thus in chlorine we found that the rate of leak was practically the same when the potential difference was 278 volts as when it was ten. The relation between the rate of leak and the potential difference thus exhibits the same general features as that between the magnetisation of a piece of soft iron and the magnetising force.

This result seems to throw light on the manner in which the electricity passes through the illuminated gas, and may perhaps be extended to conduction through ordinary electrolytes.

M. Stoletow has observed a somewhat similar relation between the potential difference and the rate of leak from a negatively electrified surface illuminated by ultra-violet light.

Mr. McClelland and I also investigated the connection between the rate of leak and the potential difference in the case of solid dielectrics, such as paraffin and sulphur exposed to the Röntgen rays. We found that this obeyed Ohm's law up to the highest potential difference (278 volts) used in our experiments, so that the potential difference required to "saturate" solid delectrics is evidently very much greater than for gases. The polarisation is also much greater for paraffin and sulphur than for gases, and it can be locked up, as it were, in the dielectrics for any length of time by screening them from the rays

J. J. Thomson.

THE EXPERT WITNESS.

We are rejoiced to see the daily press at last calling attention to the need of reform in the present system of expert witnesses, indicating that public opinion is coming round to the view which we have advocated for the past twenty-five years. The fact that scientific men, some of them even of high standing, can be procured to sustain the most contradictory views is, we have no hesitation in saying, hurtful to the interests of science, and tends to degrade science in the opinion of the public.

An easy way to secure perfectly unbiassed opinion is to insist that a scientific expert should not be called by a particular side in a case, but should be nominated by the Judge. We have urged the expansion of this system from the Admiralty Court, in which it is constantly employed, and within the past few days our opinion has been echoed by the daily press.

Commenting upon the judgments in two actions brought by the Incandescent Gas Light Company against rival companies for infringement of Dr. Welsbach's patent, the *Times* says:—

"One reflection is likely to occur to any who has watched the progress of these cases. The substantial question to be determined was one of chemistry and chemical history. The principle of law to be applied was clear and simple. A cloud of scientific witnesses was in attendance, and men of great eminence, such as Sir Henry Roscoe and Prof. Dewar, were called on both sides. The objection to this course is not perhaps very serious when the litigants are wealthy companies and the patent is of great value. But it must strike any impartial mind that the length of such inquiries would be curtailed, that the expert would be more in his true place than he often now is, and that there would be fewer exhibitions of startling conflicts between the opinions of high scientific authorities, if the Court frequently did what it is not customary to do—namely, took the evidence more into its own hands, nominating one expert, or it may be two, to report for its guidance on some of the matters of controversy. An expert reporting as the delegate of the Court would sometimes express himself very differently from one paid for his evidence, and many cases would occupy as many hours as they now occupy days."

The *Globe* also has something to say in condemnation of the present state of things, and its plain words will not be pleasant reading to men imbued with the true scientific spirit. Referring to the same cases as the *Times*, it remarks:—

"From the conflict of expert testimony, which is almost invariable in these cases, an idea has grown up that such evidence is not very valuable to the plain man, and the average juryman is much disposed, when he hears the eminent experts contradicting one another, to pay little or no attention to either side. The fact is that our whole system of taking expert evidence is founded on a wrong basis, except in the Admiralty Court, where the Judge has the advantage of professional opinion from persons occupying a quasi-judicial position. The expert who is called in an ordinary case receives a fee which varies according to his reputation, and also according to the length he is prepared to go in supporting the case of those who call him. Naturally, a plaintiff, whose case depends upon, say, a doubtful point in chemistry will search for an expert witness who takes that view of the question which is most favourable to his contention, and the defendant on his side, will look for one who does exactly the reverse. Hence there is a continual pressure being exerted upon the expert witness to go further in his evidence than would be the case if he could be impartial, and testimony becomes bewilderingly contradictory. A simple remedy for this state of things would be for the Judge to select the expert himself. There are few departments of science in which he would not know of some recognised authority, and, even if he did not, he could always obtain the information. An expert so chosen would, of course, receive his fees from the suitors, but he would give his evidence as the assessor of the Court instead of as the witness of one litigant, the truth would be much more easily got at, and cases that now take weeks would be settled in a few days."

As in most matters with which science is concerned, Germany is able to show us the best mode of action. Experts are appointed by the State at the discretion of the Judge; these may be men not suggested by either of the litigants, or chosen by both of them.

It has been legal in England for some years for a Judge to select an expert to report to the Court upon a particular matter in dispute, and this practice is occasionally followed. There is thus little difference between the status of the official English expert and the expert of the Imperial Courts in Germany. All that is needed is the substitution of official experts entirely for those called by the parties concerned. Under such a system, no question of bias could be raised, and science would not be scandalised from time to time as it is now by those who are content thus to trade on their scientific reputation, and give rise to such unpleasant insinuations as those in which the *Times* and *Globe* are pleased to indulge.

H. C. LEVINGE.

Botanic science has sustained a loss by the death, in the full vigour of middle life, of H. C. Levinge, of Knock Drin Castle, Mullingar, late Secretary to the Government of Bengal (Public Works). During his Indian career he devoted all the time he could spare from official labour to natural history, and especially to the vascular cryptogams. His collection of Indian ferns was the largest and finest hitherto made; he had himself explored more particularly Sikkim, Kashmir, the Neilgherries, and the mountains south therefrom. At the very time when, on retiring home, he was preparing to work on his superb collection, the larger and finer part of it was destroyed in the fire of Whiteley's fire-proof warehouse. From this cause, and perhaps from the excellence of the late work of Colonel Beddome on Indian ferns, Mr. Levinge, at Knock Drin Castle, devoted himself chiefly to the Irish flora. He contributed several papers to the *Irish Naturalist*, and to the *Journal of Botany*; and added no less than seventy-seven additional species to area vii. of the *Cybele Hibernica*. Most of these were from West Meath, many from the im-

mediate neighbourhood of Knock Drin. They are mainly critical or easily overlooked species as *Chara denudata*, Braun (new to the British Isles); he also discovered new localities for many very rare plants, as for *Neotinea intacta*, Reich, f.; for which see his paper in *Journ. Bot.*, 1892, p. 194. Among his Sikkim collections he found a small undescribed *Selaginella*, in which the macrospores are covered with hairs (perhaps only extensions of the tubercles frequently present) exceeding the breadth of the macrospore—an extraordinary morphologic example of the possibilities of unicellular development, and also of interest to the student of fossil botany, where similar, possibly Lycopodiaceous, spores occur.

Botanists, strangers to Mr. Levinge, who called at Knock Drin Castle, were received with domestic and scientific hospitality at once; they were instructed by the beautiful gardens; they were expedited to all the best collecting grounds in Westmeath and neighbouring counties, and the interesting plants put in their hands. His friends will unanimously agree that no more delightful man remains behind him. It is understood that he has bequeathed his collection to the Dublin Museum of Science and Art. C. B. C.

NOTES.

The French Academy of Medicine has decided to divide between Dr. Roux and Prof. E. Behring the 250,000 francs prize, founded by M. and Mdme. Victor Saint Paul as a reward to whomsoever should first discover a remedy for diphtheria.

We regret to have to record the death of the Moscow Professor of Zoology and Anthropology, Anatoly Petrovich Bogdanoff. He was born in Southern Russia in 1834, and after studying at the Moscow University, and writing, in 1858, his first dissertation on the colours of birds, he became Professor of the same University in the year 1863. In connection with this work he wrote an excellent text-book of zoology, and a still better work, unique in its kind, namely, a "Chrestomathy of Zoology," in three volumes, in which the reader obtains a thorough scientific acquaintance with the different classes of the animal kingdom by means of admirably chosen abstracts from the best authors, considerable attention being given to purely biological questions, and especially to the lowest animals, as well as to their manners of life. A couple of generations of Russian zoologists have been indebted to this admirable work. In the sixties, Prof. Bogdanoff founded, at Moscow, the well-known "Society of Lovers of Natural Sciences, Anthropology and Ethnography," whose numerous quarto volumes of *Memoirs* rank among the best scientific publications in Russia; and whose expeditions included the well-known Turkestan expedition of the late Fedchenko and Madame Olga Fedchenko. The chief anthropological work of A. P. Bogdanoff was on the inhabitants of the grave-mounds of the Moscow region. The full list of his nearly forty anthropological, and nearly thirty zoological works is given in the most valuable publication, "Materials for the History of Zoology, pure and applied, in Russia, chiefly for the last Thirty Years," of which he was the editor, and of which three volumes have already been published. His works for popularising biology, especially on Darwin's ideas, and for extending the interest in anthropology, are also numerous.

The sixty-eighth meeting of German Naturalists and Physicians will be held this year at Frankfort-on-Main, from September 21 to 26.

Our American correspondent writes, under date April 10: "Mrs. Elizabeth Mary Ludlow, mother of the late Robert Center, has given his estate, valued at 150,000 dols., to Columbia College as an endowment of 'The Robert Center Fund for Instruction in Music.' An anonymous friend has given 10,000 dols. to be expended in the purchase of books for the library. The Havemeyer family have given to Columbia College a fund as a memorial to Frederic Christian Havemeyer, with which the finest building in America for the study of chemistry will be erected, at a cost of nearly 500,000 dols. on the new site of the college. The building will be 80 × 208 ft., and four stories high. It will be finished in hard enamel, with floors of asphalt; and the corners of all rooms will be rounded so as to prevent accumulation of dust and disease germs, and the drainage system will permit every room to be washed out with a hose. Work is rapidly progressing on the other buildings, the library, the hall of physics, and Schermerborn Hall, which is devoted to natural sciences. Plans for the hall of engineering have been approved, and ground broken. The site of the chemistry building will be dedicated on May 2."

The conditions of the 1100 guineas road carriage competition have now been settled by the proprietors of the *Engineer*, and are announced in the current number of our contemporary. An arrangement has been made with the Crystal Palace Company, who have offered facilities at the Crystal Palace for showing the carriages in work there, and for holding the subsidiary trials. The judges will be Sir Frederick Bramwell, F.R.S., Mr. J. A. F. Aspinall, and Dr. John Hopkinson, F.R.S. The competition is to be international. The vehicles will be divided into four classes and one supplemental class, in each of which a prize will be given, as follows:—(*a*) For the best mechanically propelled vehicle constructed to carry (including the driver) four or more persons, the total weight, when fully loaded, not exceeding two tons, a prize of 350 guineas; (*b*) for the best mechanically propelled vehicle constructed to carry either one or two or three persons, the total weight, when fully loaded, not exceeding one ton, a prize of 250 guineas; (*c*) for the best mechanically propelled vehicle constructed to carry, in addition to the driver, not more than one ton of goods or parcels, the total weight, when fully loaded, not exceeding two tons, a prize of 250 guineas; (*d*) for the best mechanically propelled vehicle constructed to carry, in addition to the driver, five hundredweight of goods or parcels, the weight, when fully loaded, not exceeding one ton, a prize of 150 guineas. (Supplemental).—For the vehicle, whether for passengers or goods, propelled solely by a motor actuated by the vapour of oil or spirit, having a lower specific gravity than 0·8, or a flashing-point lower than 73° F., Abel's test, and constructed to satisfy the requirements of any Act of Parliament, and the rules to be made thereunder for the time being respectively in force, which, in the opinion of the judges, best satisfies the purpose for which it is built, a prize of 100 guineas. Any method of propulsion other than muscular power may be employed, provided it be contained in the vehicle. Entries are to be made on printed forms (to be obtained at the offices of the *Engineer*) at any time prior to 6 p.m. on the last day of July, 1896. Preliminary runs will be made in the grounds of the Crystal Palace with each of the vehicles in succession. The practical working run will consist of a run on the public roads of not less than 100 miles out and 100 miles home, or a total of not less than 200 miles over a course to be announced three days prior to that fixed for the run. It will probably be arranged for Monday, October 12. Any vehicle which does not complete the "practical working run" at a *minimum* average speed of five miles an hour, to include all stoppages, to be disqualified.

In reference to the article on "The Tick Pest in the Tropics," contributed by Mr. C. A. Barber to these columns last June (vol. lii. p. 197), Dr. M. Francis, Veterinarian of the Texas Experiment Station, has drawn our attention to an account by

him of the method of destroying ticks on the cattle of Texas, and, as the study of the tick pest is one of his principal duties, this description is of great value. After several unsuccessful attempts to destroy the pest by various means, the dipping process has been adopted at Texas with very gratifying results. A large vat of five thousand gallons capacity is used, and the cattle are forced to swim through it. Various carbolic and arsenical sheep-dips were employed as solutions in the vat, but the results were not satisfactory; either the cattle had to be kept in the dips for too long a time in order to kill all the ticks, or they were irritated by the solutions. This led Dr. Francis to try the effect of oil in destroying the ticks. It is well known that grease or oil, of almost any kind, is fatal to insects, lice, &c., and known facts as to the life-history and structure of ticks gave presumptive evidence that oil might be successfully substituted for the various commercial dips which had been employed. A layer, from three-quarters to one inch in thickness, of crude cotton-seed oil on the water in the vat was first used, the cattle being forced to swim through the vat, so that when they emerged they were covered perfectly with oil. This had no apparent effect on the cattle, but was found to be exceedingly fatal to the tick, and was very much superior to any other treatment tried. Dips of different nature were experimented with, but none as yet used have given such satisfactory results as the cotton-seed oil. Kerosene emulsion was found to have no practical value; crude petroleum irritates the skin, and emulsifies with water; resin oil is useless for the purpose; corrosive sublimate is too dangerous and is not very fatal to ticks even in solution 1 : 250 in water; and tobacco sheep-dips have no practical value. Dr. Francis is at present studying the effects of other oils, the most promising being West Virginia Black, a mineral oil. A full description of the construction of the vat and pen enclosure used will be found in the *Texas Farm and Ranch* of March 14.

Carnation-lovers will read with much interest a *Bulletin* just issued from the Agricultural Experiment Station of Purdue University. It is entitled "Bacteriosis of Carnations," and describes in great detail an elaborate investigation which Messrs. Arthur and Bolley have carried out on a disease with which carnations are very frequently afflicted. That this disease is caused by true parasitic bacteria, these researches appear to prove beyond doubt, and Messrs. Arthur and Bolley have succeeded in isolating the specific microbe, which they have named "Bacterium Dianthi." Although this bacillus grows readily in artificial culture media when rendered acid, producing a yellow pigment, it has only been found in nature in leaves of the carnation-pink, and infection experiments seem to indicate that it is parasitic only upon pinks, and produces no effect on the shoots, leaves, or tubers of potatoes, or on other non-caryophyllaceous plants. The disease seems to be started by these bacteria entering the plant from the air through the stomata, or occasionally by means of punctures made by aphides; whilst their passage from one cell to another is due, in the opinion of the authors, to the secretion of an enzyme, by means of which the microbe "dissolves for itself a passage-way." Although no varieties of carnation are exempt from the disease, yet they differ greatly in their susceptibility towards it. Delicate varieties and poorly-grown plants are more readily affected than vigorous and well-grown varieties. It is satisfactory to learn that such a simple precaution as keeping the foliage dry, and preventing the presence of aphides, may practically banish this disease from our carnation-houses.

A correspondent of the *Times* says:—"Within the last few weeks there has been in connection with the Dover Coal-field a transition from the experimental to the practical stage. In the last week of March the Kent Coal-fields Syndicate was formed, the capital of which was fixed at £200,000, and last week the whole of that capital was subscribed, a board of directors chosen, and a contract entered into for the sinking of two shafts as near as practicable to the Shakespeare's Cliff boring, it being stipulated that these two shafts are to be carried down to 2 ft. in. seam (1138 ft.) within eighteen months, and equipped with the most approved machinery capable of winding 2500 tons per day."

A "record" has been accomplished in measuring geodetic base lines by the Swedish surveyor Jäderin. The French staff officers, using double bars of two metals and microscopes, consider 400 metres per day good work. Hatt, in Corsica, using an encased steel ribbon 20 metres long, stretched on stands by two weights of 8 kilogrammes, advanced 500 to 600 metres per day. But Jäderin, by employing successively two wires, one of steel and the other of bronze, stretched by spring dynamometers at a tension of 10 kilogrammes, and supported on ten tripods, succeeded in measuring up to 3 kilometres in one summer-day—whether at midsummer, north of the Arctic Circle, we cannot say. From the notice which appears in the current number of the *Physical Society's Abstracts*, we learn that Jäderin's paper has not been printed.

In a valuable paper (*Atti e Memorie della R. Accad. di Scienze* in Padova, vol. xii., 1896, pp. 89–97), Prof. G. Vicentini has presented an interesting summary of his investigations on earthquake pulsations. The instrument employed is the microseismograph designed by himself (see Nature, vol. li. p. 540), and now erected in the Universities of Siena and Padua. The motion of the paper on which the pulsations are recorded is unusually rapid, and this has allowed a detailed examination of their nature to be made. Prof. Vicentini distinguishes, as a rule, three phases in each disturbance. The first consists of rapid vibrations and small oscillations; the second of large, and more or less irregular oscillations, with several maxima which begin and end abruptly; in the third phase the pulsations become more regular, and are longer in period. Throughout nearly the whole movement, but especially during the last two phases, the mean position of the pendulum generally undergoes a continuous change, showing that with the more rapid oscillations there coexist long, slow waves with a period of at least twenty seconds, which result in a gentle tilting of the surface of the ground. If the earthquake is a severe one, and the origin at a great distance from the place of observation, the three phases are separated from one another. But, as the distance of the epicentre diminishes, the first two phases partly coalesce, and the rapid vibrations are superposed on the earlier long-period oscillations. When the earthquakes are weak and of local origin, the tilting of the ground is still observed. During the slight Rovigo earthquake of May 25, 1895, for instance, the tilting at Padua took place nearly in a straight line, slowly in the first ten seconds, but more rapidly in the next twelve, when it reached a maximum of about 6″. After this, for ten seconds, an equally rapid tilt took place in the opposite direction, and this was succeeded by several smaller oscillations, of about twenty seconds each, before the motion became imperceptible.

From the Horticultural Department of the Cornell University Agricultural Experiment Station we have a "Geological History of the Chautauqua Grape Belt," a narrow plain in the State of New York, extending north-eastward from the Pennsylvanian State line, bounded on the north by Lake Erie, and south by a high range of hills, well adapted for the culture of the vine.

The Department of Entomology of the U.S. Department of Agriculture has issued an account of the San José Scale, its occurrences in the United States, and the remedies to be used against it, by Mr. L. O. Howard and Mr. C. L. Marlatt. As

many as twenty-eight different kinds of trees and shrubs are enumerated as being liable to the attacks of this pest, including most of the common fruit trees, a few varieties of pear only being exempt.

The "jack-rabbits" of Southern California and the adjoining States appear to be nearly as great a nuisance in America, as the ordinary rabbit in Australia and New Zealand. A lately published number of the *Bulletin* of the U.S. Department of Agriculture is devoted to a report, prepared by Dr. T. S. Palmer, on the jack-rabbits and their ravages, and on the best manner of getting rid of them, which is said to have become of late years a serious question in California, Colorado, Idaho, Oregon, and Utah. The so-called "jack-rabbits" belong to five species of the genus *Lepus*, which are spread over Western America from the plains of the Saskatchewan down to Mexico. They live on the open prairies, and, as they do not burrow, are compelled to trust for safety on their quickness of hearing and speed. Their ears and hind legs have been developed accordingly to an extraordinary degree. In some places they multiply to such an enormous extent that the damage done to the crops in one single county in California has been estimated at 600,000 dols., and one county in Idaho has expended more than 30,000 dols. in bounties paid for their destruction. The most effective mode of getting rid of jack-rabbits appears to be by driving them over a large tract of country into a "coral." On each side of the coral two long wings of wire-fencing are run out, and in some cases are extended to a length of six or seven miles on each side. The whole population of the country is then collected on a special day and a line formed, in order to drive the rabbits between the wings of fencing into the coral. In some cases these drives are carried out on a gigantic scale, and the number of rabbits destroyed on a single occasion runs up to 20,000. Upon the appointed day large numbers of people turn out, armed with sticks and clubs, and, scattering over a considerable area, start the rabbits and drive them towards the mouth of the coral. Every available vehicle is pressed into service, but the larger part of the throng is usually on foot. The lines gradually close in, and the frightened rabbits, urged on by blows and shouts, rush blindly into the opening between the wings, and are gradually despatched with clubs. The *Bulletin* contains a table, which shows that upwards of 370,000 "jack-rabbits" have recently been destroyed in this manner.

Result of the Grand Army Rabbit Drive at Fresno, California—20,000 Jack Rabbits killed.

The last *Bulletin* received (vol. ii. No 6) of the Imperial University College of Agriculture (Tōkyō) contains important papers (in German), all relating to the culture of Conifers, by Prof. O. Loew and Dr. Seiroku Honda.

Messrs. Henry Holt and Co. announce, among their forthcoming works, "Electricity," by Prof. Charles A. Perkins, of the University of Tennessee, and "A Problem Book in Elementary Chemistry," by E. Dana Pierce, of the Hotchkiss School, Lakeville, Ct.

The Field Columbian Museum has issued a Flora of West Virginia, by Mr. C. F. Millspaugh and Mr. L. W. Nuttall. Besides Flowering Plants the list includes the Vascular Cryptogams, Muscineæ, and Fungi; a considerable number of new species of Fungi being described. While commending the activity of this energetic Western station, we would venture to suggest, in future publications, a somewhat more careful revision of the press. Such names as *Equisitæ*, *Lycopodæ*, and *Impomæa* do not look well in a scientific publication.

We have received the Summary Report of the Canadian Geological Survey, for 1895. Although strict economy has

been rendered necessary, much good exploring work appears to have been done. The deep boring for oil at Athabasca Landing has now been continued down to over 1700 feet, with every prospect of early success when work is resumed this season. Students of Graptolites will welcome the announcement that Prof. Lapworth's work on the Canadian forms is now approaching completion.

IN a communication made before the St. Petersburg Society of Naturalists (*Proceedings*, November 1895), Prof. Borodin described some interesting species of plants which he had discovered during his last summer's exploration of the lakes of the Valdai plateau, namely, the *Isoëtes echinospora* and the *Isoëtes lacustris*, the *Lycopodium inundatum*, *Botrychium virginianum*, and *Luzula angustifolia*, Garcke, var. *albida*, which last seems to have been imported, and now grows in masses along the embankment of the Moscow Railway. He especially mentioned the simultaneous occurrence, in Lake Bologoye, of the two species, *Caulinia fragilis*, W. (*Najas minor*, All.) and *Caulinia flexilis* (*Najas flexilis*, Rostk.), which, Prof. Borodin remarks, never occur together. The former is known from many localities of Southern and, partly, Middle Russia; but the second, which is altogether a rare northern species, has only been found until now in the lakes of Finland and Olonets.

THE presidential address, delivered last December to the Geological Society of Washington, by Dr. G. K. Gilbert, has been published by the Society. It is entitled "The Origin of Hypotheses," and illustrates the methods of scientific investigation by reference to a particular problem—the origin of the peculiar crater-structure in limestone known as Coon Butte (Arizona). Involving as it does a consideration of all possible methods of the formation of a non-volcanic crater, it will be found to have a more special interest for geologists than the title might suggest.

THE Rugby School Natural History Society is one of the best of the scientific societies attached to our public schools. The report for the year 1895 has just come to hand, and we recognise in it a spirit of devotion to science worthy of the fullest encouragement. It is no small matter for a school society to spend £270 upon the purchase of objects, cases for a new museum, and for the rearrangement of the specimens; yet that is what the boys at Rugby have done. A rigid economy of many years enabled the Society to meet the entire expenses of the removal and cleaning of the objects, without appealing for help from outside, but as a consequence its resources are entirely exhausted. Funds are needed to be devoted to new cases for the entomological collection in the museum, but, we understand from the report, unless material assistance beyond the ordinary income is received, it will be a long time before the Society's exchequer will be sufficiently replenished to warrant any expenditure. We cordially commend the position of the Society to philanthropists, believing that any assistance given would work for the increase of scientific investigators. The papers contained in the report are on the flight of birds, by Mr. W. T. Loveday; the contents of the Rugby School Museum, with suggestions for their improvement and enlargement, by Mr. W. E. Collings; the functions of a school natural history museum, by Mr. L. Cumming; and on earth-worms, by the Rev. Hilderic Friend. There are also the usual reports of the various scientific sections of the Society.

THE additions to the Zoological Society's Gardens during the past week include a Red-faced Ouakari (*Brachyurus rubicundus*), from the Upper Amazons, presented by Mr. Ernest E. Austen; a Black-eared Marmoset (*Hapale penicillata*), a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mr. R. H. Biddle; two Ring-tailed Coatis (*Nasua rufa*) from South America, presented respectively by Captain Hyde and Mr. James Green; a Lion (*Felis leo*, ♂) from Africa, deposited; an Indian Civet (*Viverricula malaccensis*) from India, a Nankeen Night Heron (*Nycticorax caledonicus*) from Australia, twenty Midwife Toads (*Alytes obstetricans*) European, purchased; a Weka Rail (*Ocydromus australis*) from New Zealand, received in exchange; two Maholi Galagos (*Galago maholi*), four North African Jackals (*Canis anthus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

URANUS AND ITS SATELLITES.—As part of his work at Mount Hamilton during 1894 and 1895, Prof. Barnard took up the measurement of the positions of the four moons of the planet Uranus, and his results have just been published (*Astronomical Journal*, No. 370). Even with the 36-inch telescope the two inner satellites were usually difficult objects, while Titania and Oberon were also difficult if there was any wind to disturb the telescope. Ariel seems to be generally about half a magnitude brighter than Umbriel, and is the more easily visible notwithstanding that it is nearer to the planet. The compared brightnesses of Titania and Oberon seemed at first to show a variation of their relative light, amounting to a whole magnitude, but it is by no means certain that a real change occurs in the brightness of either; a consideration of the circumstances under which the comparisons were made has led Prof. Barnard to the curious conclusion that his eye has a tendency to make the lower of two equal lights appear the brighter, and he therefore thinks it probable that the two outer satellites are of constant and nearly equal brightness.

Apparently without being aware of the earlier observations of Schiaparelli and others, Prof. Barnard noticed a very decided ellipticity of the disc of Uranus, and found that the orbits of the satellites deviate some 20 or 30 degrees from the equatorial plane indicated by the major axis of the disc. For the polar and equatorial diameters, the measured values are 3"·93 and 4"·150 respectively, when reduced to the mean distance of Uranus from the sun equal 19·18329 astronomical units. The polar compression appears to be greater than that of Saturn, which fact indicates a rapid axial rotation. The mean diameter of the planet derived from the measures is 34,900 miles.

COMET SWIFT.—A telegram received from Kiel on April 17 announces the observation of Swift's comet at 8h., Echo Mountain mean time, on April 13 in R.A. 3h. 39m., Decl. 15° 40′ N. The comet is stated to have a tail, and was moving slowly westward. It is a little south of the Pleiades, so that it can only be observed for a short time after sunset.

A later telegram states that the comet was observed at the Lick Observatory at 8h. 26m. mean time on April 16; it was then in R.A. 3h. 38m., Decl. 18° 20′ N.

THE ASTRONOMICAL AND PHYSICAL SOCIETY OF TORONTO.—Judging by the sixth annual report, which we have just received, this Society is doing good work in popularising the study of science in Canada. The volume contains reports of the semi-monthly meetings and a series of papers read before the Society. For the most part the papers give popular accounts of various astronomical and physical researches, among which "the spectra of nebulæ," "celestial photography," and "electrical radiation" may be specially mentioned. One of the communications, by A. Harvey, describing the behaviour of minerals at very high temperatures, is very suggestive. His experiments were made by means of a Barton electrical furnace, in which the current proceeds through water to the negative pole, so that an arc is formed where the mineral at the negative pole is brought to the surface of the water. The mineral in this way becomes surrounded by an intensely heated gaseous envelope, and its surface is quickly melted, while a brilliant light is produced. When removed from the water, the crust on the surface of the mineral greatly resembles that seen in meteorites. Different minerals give out light of different colours, and usually glowing particles are detached in very much the same way as those which give rise to the trails of shooting-stars. The volume also reports the proceedings of the Committee on the "unification of time." It appears that of the nine nations publishing ephemerides, six have formally given their assent to the proposal that on and after the first day of January 1901, the astronomical day should begin at mean midnight.

PHYSICAL PHENOMENA OF THE HIGH REGIONS OF THE ATMOSPHERE.[1]

THE first and decisive cause of nearly all physical phenomena occurring in the terrestrial atmosphere is the solar heat. The atmosphere may therefore be considered an immense heat machine, of which the sun is the focus; the boiler is represented by the soil or the clouds heated by its rays, and the condenser by the radiation towards the interplanetary space.

The means by which physicists and meteorologists study the various regions of the atmosphere are very limited; they are obliged to content themselves, more often than not, with very indirect observations, and to proceed by induction. In fact, the most interesting phenomena occur in the high regions—that is to say, at almost inaccessible heights. The object of this lecture is to show by some experiments that meteorological physicists are beginning to approach very closely the real explanation of natural phenomena. You will see, in fact, that in certain cases, not only an exact image of these phenomena is obtained, but often a veritable synthesis of them may be produced by the employment of processes entirely analogous to those which really operate in nature.

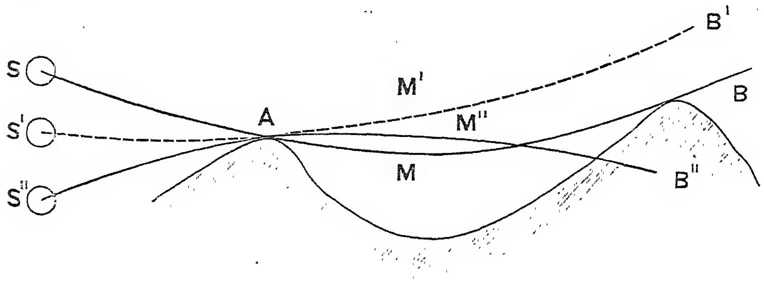


Fig. 1.

I will begin by enumerating the means in use amongst meteorologists for studying the different regions of the atmosphere.

The most direct method is the use of the aerostat; the aerostat or balloon makes it possible to take instruments of measurement to the very heart of the atmospheric regions one wishes to study. Unfortunately the method is difficult, expensive, and also dangerous; it is therefore only used in exceptional cases. The balloon ascents which have resulted best are those of Gay-Lussac (1804), of Glaisher (1862), and recently of Dr. Berson, of Strassfurt (1894), who ascended more than 9000 metres.

The most important facts observed in the balloon were very unexpected; here is the *résumé* of them:

(1) There exist very frequently clouds formed of *crystals of ice;* they constitute the cirrus, which float at very great heights.

(2) The *direction* of the *wind changes* at different heights.

(3) The temperature does not always diminish regularly with the altitude; very often *cold layers* and *hot layers* are met with *alternately*.

The second direct method for studying the atmosphere is the constructing of mountain observatories, as much as possible on isolated peaks. In these observatories the reality is daily verified of these unforeseen *inversions* of *wind* and *temperature* at different altitudes.

As for the clouds of ice, they are too high to be attained directly by the mountain observatories.

It will, perhaps, be interesting for you to know the principal mountain observatories constructed in France.

[Projection of the photographs of the following observatories:

Pic du Midi	(altitude	2800 metres)	in the Pyrenees.
Mont Ventoux	,,	1900	,,	in Provence.
Puy-de-Dôme	,,	1900	,,	in Auvergne.
The Eiffel Tower	,,	330	,,	in Paris.

[1] Discourse delivered by Prof. Cornu, at the Royal Institution. (Translated by Winifred Lockyer.)

This last observatory, owing to the lightness of its construction, entirely in open work, may almost be considered a captive balloon, permanent and fixed, 300 metres above the ground.]

Halos.—We have said that mountain observatories do not attain the region of the clouds of ice (6000 to 10,000 metres in altitude); it would, therefore, be only possible to observe them in a balloon. Fortunately these crystals of ice reveal themselves by an optical phenomenon, *the halo*, which is even seen from the low levels. It is a brilliant circle, with radius of about 22°, which encircles the sun or moon; it has a reddish tint inside, and slightly bluish tint towards the exterior. It is explained, as well as many appearances of the same kind, by the refraction of the light of the body through ice crystals; in fact, the crystals of ice are hexagonal prisms, of which the faces are in pairs inclined at 60°. These crystals, disseminated in the air, and pointing in all directions, refract the light, but the refracted rays cannot exceed the slant of 22° which the *minimum deviation* discovered by Sir Isaac Newton imposes on them; the limit of the refracted rays is, therefore, a cone of 22° round the line which joins the eye with the sun or moon.

[*Experiment imitating the Halo.*—Crystals are produced in a transparent medium, consisting of a mixture of appropriate liquids; in this way the mixture of hot and damp layers of the atmosphere is reproduced precisely, with the cold layers, which form the crystals of ice.

For this purpose a saturated aqueous solution of potash alum is placed in a glass cell, and through this cell a stream of light is made to pass, projecting the image of a circular opening representing the sun on a dark sky. Then a quarter of the total volume of rectified alcohol is added; the alum, insoluble in alcoholised water, is precipitated in very small crystals which float about in the liquid. The image of the sun is at first indistinct, as in a mist, but soon a brilliant circle, with delicate rainbow tints, appears, and represents exactly the appearance of the halo. The experiment is brilliant and instructive.]

This phenomenon is well known by country people; it is a sure sign of rain when it appears on a hot day, even if no other indications predict a metereological disturbance.

Alternation and Inversion of Temperatures.—In neighbouring observatories situated at very different altitudes, such as that of Puy-de-Dôme and Clermont, the existence of hot currents are often noted in the high regions. It is to successive inversions of the same nature that Mr. Amsler, of Schaffhousen, attributes that beautiful phenomenon known in Switzerland as "Alpenglühen," and which consists of a second illumination of the snowy caps of the Alps some minutes after they had become dark by the setting of the sun.

[Projection of a photograph of the summits of the Bernese Oberland, the Jungfrau, the Mönch, the Eiger; the view having been taken from St. Beatenberg, close to the lake of Thun. Picturesque imitation of the phenomenon by a coloured glass and proper diaphragms.]

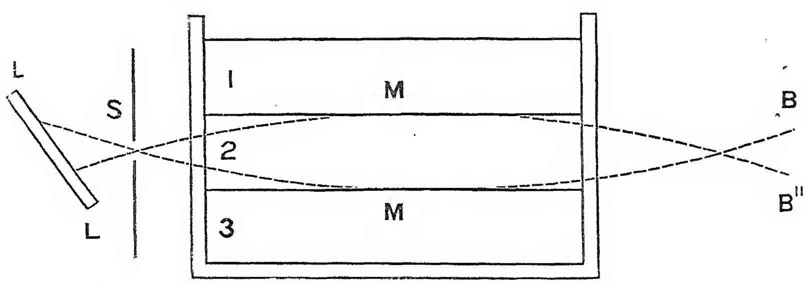


Fig. 2.—(1) Glycerine $\frac{1}{3}$, water $\frac{2}{3}$; (2) glycerine $\frac{2}{3}$, water $\frac{1}{3}$; (3) anhydrous chloride of zinc, $\frac{1}{3}$, water $\frac{2}{3}$.

Mr. Amsler's explanation is founded on the change of the direction of the curvature of the trajectory of the luminous rays depending on whether the air at the bottom of the valleys is warmer or colder than that of the higher regions.

Before the setting of the sun the ground warmed by the solar heat imprints on the trajectory a curve analogous to that of the

mirage S A M B, that is to say, convex towards the earth (Fig. 1); the sun in going down, at S′, throws the shadow of the summit A on summit B, which should therefore afterwards remain in shadow, as the sun continues to set, and as the last ray is S′ A M′ B′. But if in the interval the air of the valley gets sufficiently cold, the trajectory takes an inverse curve, S″ A M″ B″, and summit B is again illuminated.

[*Experimental Realisation of the Inversion of the Curves of the Luminous Trajectories.*—With a little care it is possible to superpose in a transparent cell of about 20 centimetres thickness three layers of liquid, of which the composition is given under Fig. 2. A movable mirror, L L, throws a stream of light through the opening, S, of a diaphragm. This beam of light, sent under different inclinations, is reflected either by the inferior layer of chloride of zinc (dense, but less refracting), or by the layer of diluted glycerine (lighter and also less refracting than the intermediate layer).

A little fluorescene illuminates the trajectory of the streams of light, and renders their curves visible; the Alpenglühen can thus be represented with a few accessory arrangements.]

Scintillation of Stars.—This phenomenon is also a proof of the alternation of the temperature and of the movement of the layers of air in the high regions. Spectrum analysis shows that the scintillation is produced by a disappearance following a regular order (in accordance with the variation of the zenith distance of the star) of the successive colours of the spectrum.

[*Imitation of the Phenomenon.*—It is obtained by a very brilliant experiment, which consists in throwing the image of a luminous opening, O, with the help of a lens, L, on a little silvered ball, B, of 3 or 4 centimetres in diameter, resting on black velvet. Thus the aspect of a fixed star is obtained, with remarkable brightness (Fig. 3).

But the luminous opening, O, is made in a card, on which is thrown the spectral image of a slit, F, which is dispersed by a direct vision prism, P.

In fact, it is the transformation of the solar energy into mechanical energy which is the fundamental phenomenon; it brings all others with it. It is the only transformation which, for shortness, I shall deal with here.

The simplest mechanical phenomenon which is produced in the atmosphere is the wind. The origin of the wind is the difference of pressure between two points more or less distant; since the time of Pascal, it is known that the pressure of air is measured by the barometer. It might be thought, according to this property, that the direction of the wind is always determined by the indications of this instrument; that is to say, that the wind must go from the point where the barometric pressure is strongest to the point where the barometric pressure is feeblest.

Well, this is hardly ever the case; the real direction of the wind is always oblique to this theoretical direction. This fact has only been known a very few years; it is the general meteorological maps, suggested by Le Verrier about thirty years ago, and so universally known at the present day, which have put this fact beyond doubt.

The direction of the wind seems to *turn round* the point of the map where the *minimum* pressure is to be found, in the *opposite direction* to the hands of a watch; or, rather, in a *direct sense* round the point of maximum pressure. Such is the direction of the phenomenon in the *northern hemisphere*; it is contrary in the southern. In fact, the most ordinary movement of the atmosphere is a *gyratory* movement, which is called a cyclone.

The whirling movement of the air has been observed for a long time; we often see it produced around us. The dust, the dead leaves are lifted by the wind in a whirlwind resembling eddies in rivers. Sailors know of *cyclones* and *water-spouts*, and fear their dangerous effects. On the American continent there are terrible hurricanes called *tornados*. These gyratory movements seem only to belong to great stormy perturbations; but the more the study of the atmosphere is followed in detail, the more it is seen that this kind of disturbance is met with in all

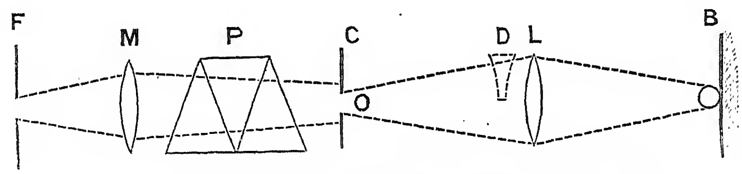


Fig. 3.—Arrangement for imitating the phenomenon of the scintillation of stars.

In truth, the card, C O, is not in the focus of the spectrum, which focus is formed further off, in the plane of the lens L. The result is that the rainbow image of the slit on the card has a white part in its centre; it is there that the opening, O, is placed. Also the light thrown on the ball, B, is entirely colourless. But the beam of light, on coming out of the opening, expands into spectrum on the lens of projection L, which recomposes it in B, as in a celebrated Newtonian experiment.

Then by placing a screen with large meshes before the lens L, certain radiations are taken away, and the star, B, appears coloured.

A *divergent half-lens*, D, with same focus as L, cancels its effect, and the spectrum of the star, with the artificial bands created by the screen, appears on a white screen by the side of the ball. This is the imitation of the spectrum analysis of the scintillation of stars.]

It is seen by these few examples that the study of the *optical phenomena* of the atmosphere, aided by physical analysis and *synthesis*, can, and must, teach much about the calorific phenomena of the regions beyond our reach.

Dynamic Phenomena of the Atmosphere.—The phenomena studied up till now are due to conditions of almost perfect equilibrium in the atmospheric layers; they might be called *static*. But the calorific action of the sun, combined with the cooling action of radiation in space, can produce phenomena of movement representing every degree of intensity, from the feeblest to the most violent: we call these phenomena *dynamic*. They make themselves apparent in very different ways.

(1) Under the form of *mechanical energy*: winds, whirlwinds, cyclones, water-spouts, &c. (2) Under the form of *calorific energy*, which makes itself felt by the formation of clouds, rain, hail corresponding to different changes of state of water, the element of the atmosphere which is continually varying. (3) Under the form of *electric energy*: lightning, thunder, &c.

manifestations of displaced air. It is therefore concluded that the gyratory movement is to some extent the *normal* condition of agitated air; it would hardly be possible to employ force on a gaseous mass without developing more or less rapid rotations, which tend to acquire for themselves a permanent condition.

Experimental Proofs.—Every time a rapid jet of gas is produced, one or more cyclonic movements are formed at the side of the jet. If the projected column is of a cylinder shape, the cyclonic movement will take the form of a ring; for example, the rings of smoke which are observed after the explosion of cannons, guns, &c.

[Repetition of the well-known experiment of smoke-rings, produced by striking the canvased end of a box filled with vapour of hydrochlorate of ammonia, with a circular opening on the opposite side. The smoke-rings are rendered visible by throwing them in the line of a beam of electric light.]

Multiple Origin of the Gyratory Movements of the Atmosphere.—Nearly all the general causes which act on the movement of the atmosphere are gyratory influences; when once the movement is set going, it continues of itself, and sometimes increases in amount; in the first place, the movement of the rotation of the earth must be cited, which always brings with it a small component of rotation for a displacement of a gaseous mass in *latitude* or *altitude*; in the second place, and as decisive cause, the solar heat, which warms the air near the surface, or the clouds. As the ascending tendency of the heated gas cannot be equal over the whole surface exposed to the rays of the sun (as much because of the nature of the ground as because of its inequalities), the equilibrium is upset in certain parts, and gaseous columns ascend. This is, therefore, the same case as the jets, quoted above, and consequently under favourable circumstances for gyrations round horizontal axes. When once the gyration is established, the causes which have produced it keep it up and augment it.

The existence of whirlwinds with horizontal axes in hail-storms, particularly in that of May 20, 1893, at Pittsburg, has been observed by an American meteorologist, Mr. Frank W. Very, and has furnished him with a very ingenious explanation of the formation of hail. Indeed, such a whirlwind (if it has sufficient dimensions) takes the hot and damp air of the surface of the ground to high and cold regions; the vapour condenses, freezes, and crystals of ice are brought into the gyratory movement; they ascend and descend alternately, following the spirals of the whirlwind, and increase at every passage in the inferior regions, which are charged with humidity. This explanation accounts for all the peculiarities which are observed in a fall of hail: zoned structure, very low temperature; special sound before the fall; electric manifestations which accompany them; for a whirlwind of hail is a veritable influence electric machine, a sort of *replenisher*.

Artificial Reproduction of Natural Gyratory Phenomena.—The phenomena produced by the rapid rotation of the air are altogether unexpected in consequence of the singularity of forces put in play. The ordinary laws of mechanics, to which daily experience has accustomed us, seem entirely different to those which the cyclonic movements seem to obey; and this must not astonish us. We have reduced mechanics to its simplest elements; the material point, the constant force, the rectilinear movement: thanks to these simplifications, we have been able to understand the movement of spherical projectiles, that of a pendulum, the rotation of a fly-wheel, &c. But as soon as the solid body becomes complex as to its form, when the movement which it may take has at the same time a translation and a rotation, our imagination represents it badly; if to this complication of form we add the resistance of the surrounding medium, then we have no idea of the probable resulting effect; for example, the *boomerang*. As to the movements of fluids, they are so difficult for us to foresee, that we receive fresh surprises every time we move a vessel of water; as soon as the mass of water is at all considerable, the tumultuous movements, which we unwillingly cause, always produce some awkwardness.

We understand then how impossible it is for us to anticipate the atmospheric movements, of which the mass is so immense, for each cubic metre weighs 1,300 grs.; if the energy expended in setting in movement such masses is considerable, inversely the stability of the system is enormous, since we have to wait for the dissipation of this energy by the passive resistances, almost always reduced to friction on the earth's surface.

We will, therefore, not endeavour to analyse the forces put in play in the gyratory movements of the air. I will limit myself to repeating before you some of the beautiful experiments of M. Ch. Weyher, who has been good enough to come himself to help me arrange the apparatus now before you.

Here is a sphere composed of ten circular paddles, put in rapid motion round axis A B (Fig. 4); the air caught in the rotation produces a general whirlwind movement, symmetric in relation to the plane of the equator. On all sides the air is sucked in by the revolving sphere, which may be seen by the effect on smoke or pieces of paper brought near it. This air is expelled from the equatorial circumference, and only in the almost mathematical plane of this circumference; in fact, look at these pieces of paper which keep themselves concentrically to the equator, following an arrangement which reminds us of Saturn's ring. The tension of the paper and its vibrations show that it is the repulsion of the equatorial outflow which maintains them.

It might be concluded from this, that the revolving sphere could only produce equatorial repulsions; but the complexity of the turbulent streams baffles the most evident anticipations. If a light balloon be approached a little distance from the sphere, it is immediately attracted, and begins to revolve rapidly round the sphere in the equatorial plane; if a second or third be let loose in the same way, they will follow it at varied velocity, and represent satellites; the planetary configuration is complete.

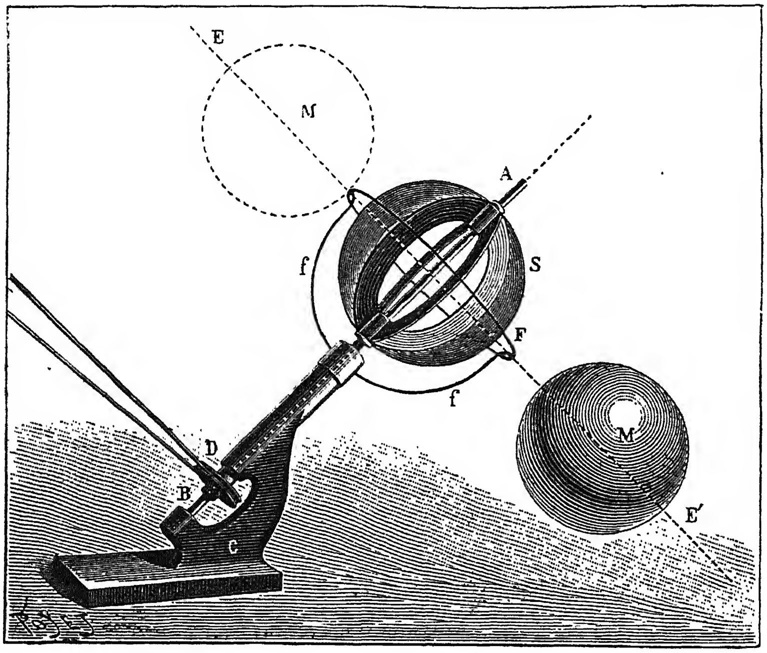


Fig. 4.—Artificial reproduction of the gyratory natural phenomena.

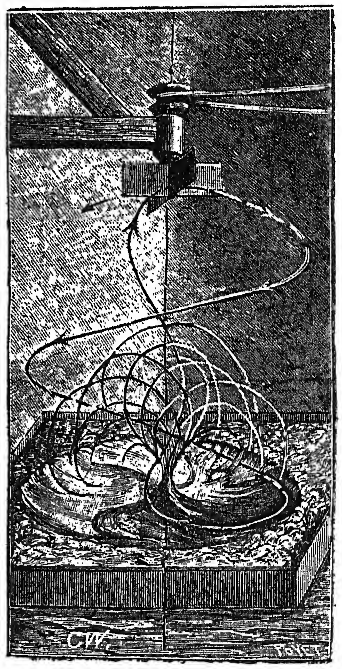


Fig. 5.

This paradox of a repulsion transformed into attraction by a change of form of the presented body, is easily solved by considering the resultant of aspiring and repelling actions on the surface of the moving body. On the greatest angular space round the revolving sphere it is the whirlwind attraction which dominates. This is easily proved by placing underneath this sphere a basin full of hot water; if the atmosphere of the room is quiet, little by little the vapour will be seen to collect in a whirl from the surface of the water to the revolving sphere (Fig. 5). This is the imitation of a water-spout. The importance of this phenomenon has led M. Weyher to reproduce it in a more striking way, and by bringing into play a much more considerable quantity of mechanical energies, thus recalling better those which constitute this natural phenomenon.

The excitement of the gyratory movement (which, in nature, has its source in higher regions of the atmosphere) is produced by a small mill, placed three metres above a reservoir of water four metres in diameter (Fig. 6). When the small mill is made to revolve (400 to 500 revolutions a minute), the aerial whirlwind sucks up little by little the surface of the water, which is

seen to be agitated and to be forming *centripetal* spirals, and producing a liquid cone several centimetres in height. Above this cone a great number of little drops accumulate, which fall back in spirals. This attraction, *at a distance*, is even more striking if the water is slightly heated; the vapour then forms a *hollow* tube, of which the hollow part is distinguished by its dark colour and its geometrical regularity; it shoots forth from the water towards the small mill, causing light objects, such as bits of straw, which are floating on the liquid, to be thrown up.

Such is the experiment which in 1887 was made in the open air at the great works of the Weyher and Richmond Company. With the reduced apparatus, now placed before you (Fig. 6), we can repeat it in conditions quite as convincing. The small mill is placed at the top of the case two metres high, closed on one side by a glass; the water, slightly warmed and containing a little soap, is placed at the bottom of the case in a basin. I set the small mill going; you see the agitation at once, the soap-bubbles precipitate themselves at the foot of the column of vapour. Soon the column takes the form already described, and represents exactly the appearance of a real water-spout; at the foot is the *buisson*—that is to say, the collection of bubbles and little drops; at the top, the expanded hollow tube of vapour.

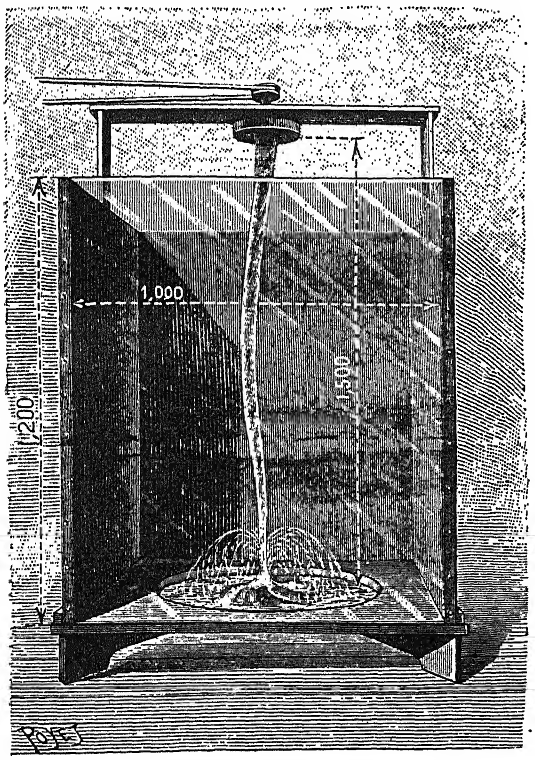


FIG. 6.—Artificial reproduction of a water-spout.

A light balloon placed at the surface of the water is first carried to the centre, and rendered captive at its foot; by quickening the rotation (which increases the power of the whirlwind) the balloon is raised by the water-spout, and sometimes follows the spiral the whole of its height.

The helicoidal movement of this light balloon, as well as the aspect of the nebulous spiral, shows well the constitution of the water-spout; one sees the superposed rolls of helicoidal currents, some ascending, others descending (Fig. 7); it is a perpetual going and coming between the mill and the surface of the water. As all the currents turn in the same direction if the ascending ones *screw* to the *right*, the descending ones *screw* to the *left*. It is the absence of having recognised this double movement of ascent and descent which is at the bottom of the misunderstanding between the partisans of ascending water-spouts and those who maintain that they are only descending phenomena.

The ascending movement of the light balloons caught up by the water-spout, shows well the ascending velocities; it is more difficult to put in evidence the descending region, declared in some theories to be the only existing one, because it occupies in the reduced experiment a very small space; it is confined to the interior of the nebulous sheath, of which the hollow centre is distinguished by its dark colour. I will, however, show it to you with the help of a very simple artifice. Take a body emitting smoke to the top of the water-spout; we see this aspirated smoke at once reach the interior of the sheath, roll itself into a slender cone, and descend to the surface of the water. This is exactly what is seen in nature when, in a water-spout, the clouds descend in the form of a stream which grafts itself in the middle of the *buisson* formed by the water at the surface of the boiling sea. This spiral is, so to speak, the harmless part of the water-spout; the terrible part is invisible; it is formed by the mass of air which rages round the spiral. In the experiment before us it is contrary. The raging mass is visible owing to the smoke which is supplied; the interior of the spiral remains dark; it is by the introduction of the smoke that the existence and form are recognised.

There still remains to show you that with a similar arrangement a cyclone can be produced with all its characteristics—variation of pressure at its passage, barometric minimum, central

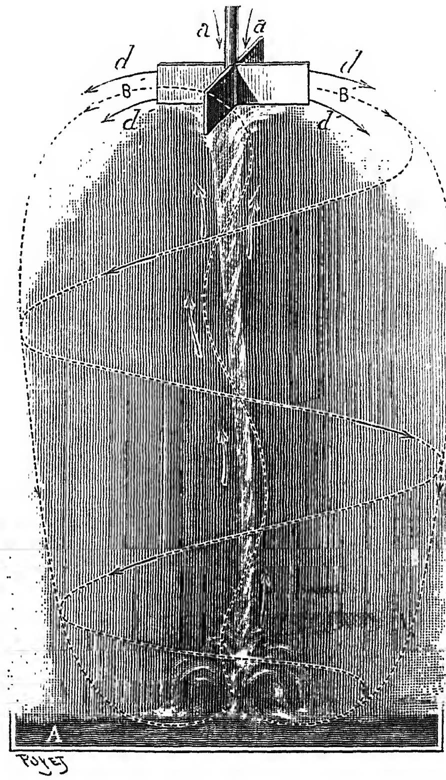


FIG. 7.—Double direction of liquid currents in a water-spout.

calm, brisk rising of wind, centre of the storm, &c.—which has also been attained by M. Weyher.

The following remarks have been subsequently added to the lecture at the Royal Institution:—

We will conclude by describing with some detail that experiment which reproduces so accurately all cyclonic phenomena. In reality a cyclone is nothing else than an immense aërial whirlwind; it only differs from a water-spout by its proportions, and principally with respect to the height and the diameter; in a water-spout the diameter is very small in relation to the height, whereas in the cyclone it is the contrary. But in both cases the general movement is the same; the aërial currents descend all around, to remount immediately on the interior spirals, with a diameter more or less great, but leaving, as in a water-spout, a central region free, in which the descending movement is equally to be found.

Here is a flat rotating disc, about 1 metre in diameter, mounted on the extremity of a crane 2 metres in radius; by means

of this arrangement it is possible to make the rotating disc travel horizontally above a large table in which are fixed a great number of pins, to the head of each of which is attached a bit of wool some centimetres in length, and thus forming many flags, which will show us the directions of the wind in each point traversed by the cyclone. In the centre of the table a hole is pierced communicating underneath with a very sensitive barometer, which will show us the variations of atmospheric pressure at the passage of the meteor (Fig. 8).

We set the rotating disc in rotation after having placed it above one of the extremities of the table; you see at once all the flags situated underneath indicate the directions of the wind. Those which form the centre of the whirlwind remain flat and rest inert on the table, their extremities directed one towards the other. They represent wonderfully well the central calm.

The flags surrounding the central calm form a circumference; they imply a wind forcing them all in a direction slightly centripetal, and ascending. In the following ranges the pieces of wool place themselves again along a circumference, but scarcely showing the centripetal direction, and not at all the ascending one; then the more distant the flags are from the centre, the more they inflect towards the table, and indicate the descending wind; at the exterior circuit the wool takes centrifugal directions; it is air which escapes from all sides on the borders of the cyclone.

Now, if we make the artificial cyclone travel horizontally, by moving the crane on its pivot, you will see that the central calm shows itself every instant at a new place, which is very easily observed by the aspect of the flags occupying the centre, which fall down suddenly and rest inert on the table. On the other hand the flags immediately adjacent raise themselves quickly, caught up by the tempest, and those which but recently were

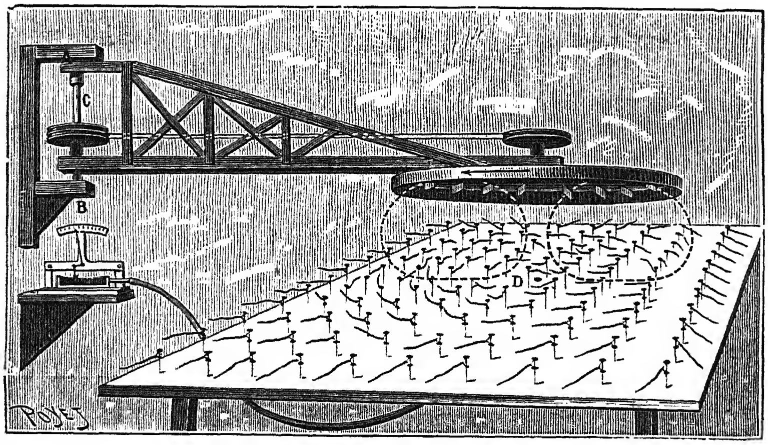


FIG. 8.—Artificial reproduction of cyclonic phenomena.

pointing in one direction, turn all at once in the opposite one, and make it possible to observe with all its sharpness the abrupt change of wind which takes place on leaving the central calm.

By making the cyclone travel with sufficient quickness, the flags permit us to take note of the dangerous and manageable sides of a cyclone, according as one looks at the semicircle in which the wind turns in the same direction as the movement of translation, or in the opposite one.

The variations of pressure are indicated by the passage of the cyclone above the hole made in the table, and communicating with the barometer; you see the needle falling little by little, indicating the minimum precisely at the moment when the centre of the cyclone passes above the hole, then rising slowly.

A thermometer sufficiently sensitive, placed in the centre of the cyclone, allows us to observe a rise of temperature.

In great cyclones, a ship on reaching the centre not only finds a general calm, but the sun or stars may be seen to shine through a great opening in the clouds; it is the eye of the storm.

In order to explain this fact, it suffices to remark that a cyclone is only in fact a water-spout of enormous diameter, in the immense sheath of which rages the storm of a descending movement, dragging down the hurricane and the clouds from the high regions to the level of the sea; but, as in the water-spout, the central nucleus remains free, and allows a clear sky to be seen.

The realisation of this eye of the storm succeeds equally well with steam or smoke by taking necessary precautions with the experiment.

Finally, as the centre of the cyclone is free of water vapour (at least in the visible form), whilst in the enveloping sheath storm and darkness reign, is it not evident that a hygrometer placed in this cloudy sheath will show a degree of moisture above that of the central nucleus?

To sum up—it may be seen that, however small the scale of the experiments in comparison to that which passes in nature, nevertheless these experiments reproduce with fidelity and with all the particularities of the great natural meteorological phenomenon.

The experiments which you have just seen will, I hope, suffice to show you how complete the experimental syntheses are, and how they represent the natural phenomena in the smallest details.

I will conclude by making the simple remark that meteorology gains in extent and certainly when we treat it as an experimental science.

A. CORNU.

IMMUNISATION AGAINST SERPENTS' VENOM, AND THE TREATMENT OF SNAKE-BITE WITH ANTIVENENE.[1]

II.

THE experiments now to be described were made with antivenene derived from a horse which had last received a dose of cobra venom estimated to be twenty times the minimum-lethal. On some previous occasions I have stated the results of observations on the antidotal value of the blood-serum of rabbits which had last received thirty and fifty times the minimum-lethal. The antivenene obtained from cats and white rats has also been examined. The special interest, however, is attached to antivenene derived from the horse, that it is more likely than any others to be used in the treatment of snake-bite in man.

The experiments were so planned as to obtain in different conditions of administration as exact a definition as possible of the antidotal power of the antivenene. In the meantime, four series of experiments have been undertaken on rabbits. In one series the venom was mixed outside of the body with the antivenene, and immediately thereafter the mixture was injected under the skin of the animal; in the second series the venom and antivenene were almost simultaneously injected into opposite sides of the body; in the third series the antivenene was injected some considerable time before the venom; and in the fourth series the venom was first injected, and thirty minutes afterwards the antivenene.

In the experiments of the *first series*, the doses of cobra venom administered were the minimum-lethal, one-and-a-half the minimum-lethal, twice, thrice, four times, five times, eight times, and ten times the minimum-lethal. In the case of each dose of venom, experiments were made with different quantities of antivenene, until the smallest quantity required to prevent death was discovered. In order to render it certain, in this and in the other series, that a lethal dose had been administered in the experiments with the so-called minimum-lethal, the minimum-lethal indicated by previous experiments was not used, but instead of it a slightly larger dose (·00025 instead of ·00024 gramme per kilogramme).

When this certainly lethal dose, capable of producing death in five or six hours, was mixed with the antivenene, and the mixture injected two minutes afterwards, under the skin, it was found that so small quantities were sufficient to prevent death as ·001 cc., ·0008 cc., ·0005 cc., and ·0004 cc. (1/1000, 1/1500, 1/2000, and 1/2500 of a cc.) for each kilogramme of the weight of animal; with ·0003 cc. (1/3333) per kilogramme, however, the animal died. The antivenene was therefore found to be so

[1] Continued from page 572.

powerful as an antidote, in the conditions of these experiments, that even the 1/2500 part of a cubic centimetre, equivalent to about the one-hundred-and-fiftieth part of a minim, acted as an efficient antidote, while even with the one-two-thousandth part of a cubic centimetre not only was death prevented, but there was almost no symptom of poisoning produced. In the experiments of this series with one-and-a-half the minimum-lethal dose, recovery occurred when the doses of antivenene were ·32 cc., ·3 cc., ·28 cc., ·25 cc., and ·24 cc. per kilogramme; but ·23 cc. and ·2 cc. failed to prevent death. In the experiments with twice the minimum-lethal dose, recovery occurred when the doses of antivenene were ·5 cc., ·4 cc., and ·35 cc.; but ·3 cc. and ·2 cc. failed to prevent death. In the experiments with thrice the minimum-lethal dose, a dose capable of producing death in less than two hours, recovery occurred when the doses of antivenene were ·7 cc. and ·65 cc.; but death occurred with ·6 cc., ·55 cc., and 5 cc. With four times the minimum-lethal dose, recovery occurred with 1·5 cc., 1·3 cc., and 1·2 cc., and death with 1 cc. With five times the minimum-lethal dose, recovery occurred with 2·5 cc., 2·2 cc., 2 cc, 1·8 cc., and 1·5 cc.; but death with 1·3 cc. With eight times the minimum-lethal dose, recovery occurred with 2·6 cc. and 2·5 cc.; but death with 2·4 cc., 2·3 cc., and 2 cc. And even the enormous dose of ten times the minimum-lethal failed to produce death, or any important symptoms, when it had previously been mixed with 3·5 cc. and 3·4 cc. of antivenene for each kilogramme of animal; and it only succeeded in producing death, although not until the lapse of several hours, when the doses of antivenene were 3·3 cc., 3·2 cc., 3 cc., and 2·5 cc. per kilogramme.

These results show a remarkable, an almost directly proportional, accordance in the increment required in the dose of antivenene for each increment in the dose of venom. In the diagram the comparatively straight direction of the oblique line separating the fatal from the non-fatal experiments is noteworthy, considering that the conditions of the experiments, in regard both to the animals and the substances used, could never be absolutely the same. Indeed, from twice the minimum-lethal dose of venom upwards, the addition of little more than ·3 cc. per kilogramme represents the addition in the quantity of antivenene required for each addition of a minimum-lethal dose of venom. Apparently the antivenene is able in this proportion to prevent death from almost any lethal dose of venom, however large it may be.

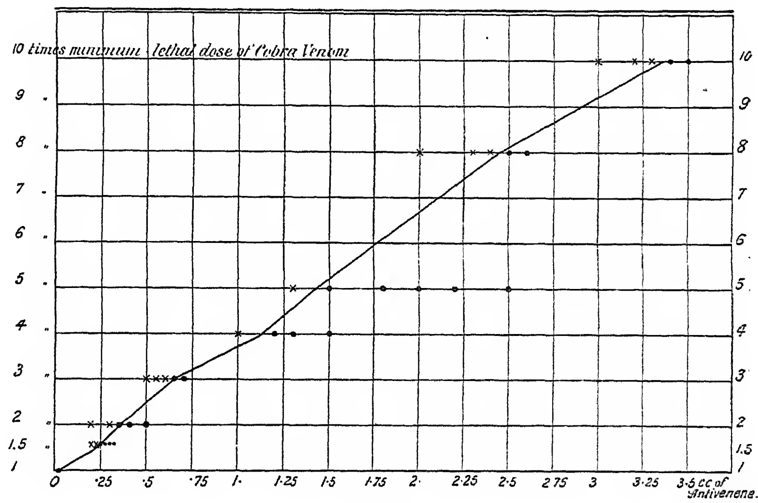


FIG. 2.

These results are in marked contrast with those that occur when an antidote acts because of its physiological properties, and they alone suggest that the antidotism is rather the effect of a chemical than of a physiological reaction. The indications obtained with doses of twice the minimum-lethal and upwards cannot, however, be carried down to the minimum-lethal dose. The quantity of antivenene required to prevent death from this dose is much less than might have been anticipated when the results of experiments with larger doses are considered. Thus, it appears that while ·35 cc. of antivenene per kilogramme is required to prevent death from twice the minimum-lethal of venom, the minute quantity of the 1/2500th of a cc., or nearly 1000 times less (·0004 as compared with ·35 cc.), is sufficient to prevent death from a little more than the minimum-lethal dose of venom. It is apparent that this minute quantity of antivenene does not render inert the whole of the minimum-lethal dose. All that is required in order that the minimum-lethal dose should not produce death being that only a minute portion of it should be rendered inert; for, if this dose be the actual mininum-lethal, the rendering inert of any portion of it, however minute, will prevent the remainder from causing death.

In the *second series*, experiments with the antivenene of the horse have been completed only with one-and-a-half the minimum-lethal dose of venom. When this dose was injected into the subcutaneous tissues of one side of the body, and, immediately thereafter, a dose of antivenene into the subcutaneous tissues of the opposite side, it was found that antivenene in doses of 3 cc. and 3·3 cc. per kilogramme failed to prevent death, but that 3·5 cc. and 3·6 cc. per kilogramme were able to do so.

In the *third series*, experiments have been made with the minimum-lethal, one-and-a-half the minimum-lethal and twice the minimum-lethal dose of cobra venom. With the first of these doses, recovery occurred with ·5 cc., ·45 cc., and ·42 cc.; but death with ·4 cc., ·3 cc., and ·25 cc. of antivenene, administered thirty minutes before the venom. With one-and-a-half the minimum-lethal of venom, 2·9 cc. and 2·7 cc. of antivenene were able to prevent death; while 2·6 cc., 2·5 cc., 2·3 cc., and 2 cc. each failed in doing so. With twice the minimum-lethal dose of venom, recovery occurred when the doses of antivenene were 5 cc., 4·5 cc., and 4 cc.; but 3·9 cc., 3 8 cc., 3·5 cc., 2·5 cc., and 2 cc. were insufficient to prevent death.

In the *fourth series*, where the results give the truest indications of the antidotal value of antivenene in the actual treatment of snake-poisoning, it was found that recovery occurred in the experiments in which ·8 cc., ·7 cc., and ·65 cc. per kilogramme of antivenene was injected thirty minutes after an assuredly minimum-lethal dose (·00025 per kilo.) of venom; but that the antivenene was insufficient in quantity to prevent death when ·6 cc. or any smaller quantity was administered. In this series, further, it was found that 3·4 cc. and 3·2 cc. per kilogramme of antivenene were sufficient doses to prevent death after one-and-a-half the minimum-lethal dose of venom, but that 3 cc., 2·8 cc., and 2·5 cc. per kilogramme were insufficient. In a corresponding series of experiments made with the antivenene derived from rabbits which had last received thirty and fifty times the minimum-lethal dose of cobra venom, it was found that 5 cc. per kilogramme of this antivenene was the smallest dose by which death could be prevented in an animal which had received twice the minimum-lethal dose of venom thirty minutes previously.

Attention is conspicuously drawn by these facts to the remarkable difference in the dose of antivenene which is required to prevent death when it is mixed with the venom before administration, as contrasted with the doses required when the two substances have not previously been mixed together. Restricting attention to the experiments in each series in which the dose of venom was the same—to the experiments with one-and-a-half the minimum-lethal dose, for instance—it appears that in order to prevent death, when this dose was mixed with antivenene before administration, only ·24 cc. of antivenene is required; whereas when both substances were injected simultaneously, but under the skin at different parts of the body, the required dose of antivenene is 3·5 cc.; when the antivenene was injected thirty minutes before the venom, it was 2·7 cc.; and when the venom was injected thirty minutes before the antivenene, it was 3·2 cc. per kilogramme.

It is impossible to consider the great difference between the dose of antivenene required when the two substances, though in

each case simultaneously administered, are, in the one case, mixed together before injection, and in the other not so mixed, without again having the suggestion originated that the antidotism is the result of chemical and not of physiological reactions.

This suggestion receives a further support from the fact, observed in several experiments, that the longer before their administration the two substances were allowed to remain together after they had been mixed, the greater is the antidotal efficiency of the antivenene. Thus, while 1·3 cc. per kilogramme of antivenene, mixed with five times the minimum-lethal dose of venom, was followed by death when the two had been mixed together five and also ten minutes before administration, this mixture was, on the other hand, followed by recovery when the interval before the administration was extended to twenty minutes. In order to obtain uniform and comparable results in the first series of experiments, it was therefore found necessary to adhere, in all the experiments made with the larger doses of venom, to a time limitation of not more than ten minutes before the mixed substances were injected.

I have also administered cobra-antivenene thirty minutes after a dose one-twelfth larger than the minimum-lethal of the venoms, respectively, of the *Sepedon hæmachates*, the *Crotalus horridus*, and the Diamentina serpent; and the animals experimented on have recovered when the dose of cobra-antivenene was not smaller than 1·5 cc. per kilogramme. This successful result is all the more remarkable when the intensely destructive effects produced by even smaller doses of each, but especially of two, of these venoms is recollected.

The antivenene derived from rabbits which had been protected to the extent that they had last received fifteen times the minimum-lethal dose of the Diamentina venom has also been tested against the Diamentina venom itself. When the two were administered together, after having been mixed *in vitro*, this antivenene in a dose of ·05 (1/20) cc. per kilogramme was able successfully to antagonise slightly less than one-and-a-half the minimum-lethal dose of the venom; but ·025 (1/40) cc. per kilogramme failed to do so.

In the experiments which I have hitherto described, and, indeed, apparently in all others made in this new subject of serum therapeutics, protection has been produced, and the antidotal properties of the antitoxic blood-serum have been tested, by the subcutaneous, or, less frequently, by the intravenous injection of the venom or other toxic substance. No endeavour seems to have been made to discover how far the same effects, or what effects, may be produced by stomach administration.

Anticipating that results of an interesting nature might be obtained by this method of administration, I have adopted it for the introduction of both antivenene and venom into the body, and the results have even exceeded my anticipations.

The plan followed was the simple one of mixing the substances, previously dissolved in water, with a small quantity of milk, and allowing white rats, which had not received any food for several hours previously, to drink this milk. In the meantime, I will briefly describe only those experiments in which antivenene was thus administered, reserving, for a few minutes, a description of the results that were obtained when the venom itself was used.

The first experiments were made with the object of determining if, by repeating the process followed in the production of immunity, with the exceptions that the administrations were by the stomach and that antivenene was substituted for venom, an animal could be protected against the poisonous effects of venom. With this object, a white rat received on alternate days during several weeks, doses of antivenene, which were gradually increased from 1 to 10 cc. per kilogramme, and then, by subcutaneous injection, one-and-a-half the minimum-lethal doses of cobra venom; with the result that death was not produced. Other white rats received 10 cc. per kilogramme on each of four days, and on the fifth day 15 cc. per kilogramme of antivenene, and still recovery took place when one-and-a-half and one-and-three-quarters the minimum-lethal dose of venom was injected under the skin. To other white rats, 10 cc. and 15 cc. of antivenene were given by the stomach, on two successive days, and on the second day, one-and-a-half the minimum-lethal dose of venom, and the result also was that death was prevented. It was thus suggested that a single administration of antivenene might be as efficacious as a succession of administrations; and accordingly, the antidotal efficiency of single doses of 7 and of 10 cc. per kilogramme was tested, in some instances three hours, in others two days, and in others three days before one-and-a-half the minimum-lethal dose of venom was subcutaneously injected; and in all cases the animals recovered. When, however, 5 cc. per kilogramme of antivenene was thus administered three hours before, and 10 cc. per kilogramme three days before, one-and-a half the minimum-lethal dose of venom, the animals died.

The experiments have not as yet been carried further, but I hope to continue them so that the limits of the antidotal power of the antivenene, and the duration of the protection after single doses of antivenene, may be defined. Enough has, however, been done to prove that the stomach administration of antivenene, equally with its subcutaneous administration, confers protection against lethal doses of serpents' venom, and to justify the use of antivenene by the former and more convenient method for the purpose of securing protection for, at least, a period of several days after a single administration of the protecting antidote.

The facts hitherto narrated are sufficient to establish that the protection acquired by animals as a result of the administration of venom is not chiefly, or even to any important degree, caused by the venom having produced a tolerance by accustoming the body, as it has been expressed, to the presence of the venom—although a certain degree of this protection may possibly be due to such accustoming—but rather to the presence in the body, as a result of the introduction into it of venom, of a definite substance having antivenomous qualities. Notwithstanding the powerful protective and antidotal action of this substance (antivenene) against serpents' venom, it is instructive to find that it is itself almost devoid of any physiological action, for even very large quantities may be injected under the skin without producing any other physiological reaction than a moderate degree of irritation in the neighbourhood of the injection. How then are we to explain the operation of this physiologically inert substance in protecting an animal against even fifty times the minimum-lethal dose of venom, or by a single administration of it, in saving an animal from death after there has been introduced into its body more than twice the quantity of venom that is required to kill it? When an answer has been attempted to be given to this question in discussions in the wider field of the serum therapeutics which deals with the toxines of diseases, the answer has been found either in the destructive power of phagocytes upon microbes and their toxines, or in the theory that the toxine elaborates from the blood the antidotal antitoxine, which, whether thus originated or separately introduced into the body, confers upon the body a resisting power which enables it to oppose successfully the injurious action of the toxines.

These answers cannot solve the problem in so far as snake venom is concerned. Phagocytosis cannot, of course, operate *in vitro* in solutions which are free from organised structures. Even when solutions of venom and antivenene, mixed together *in vitro*, have been inserted into the body, it is incredible that the increase in the quantity of antivenene by the 1/500th part of a cubic centimetre could cause such an increased proliferation of leucocytes as to prevent a lethal dose of venom from producing death, whereas a dose only the 1/500th part of a cubic centimetre smaller would be unable to do so. Further, there is no observable increase of leucocytes when much more than these infinitesimal quantities of antivenene have been administered to an animal.

In view of many of the facts that have to-night been stated, the "resistance of tissues" theory is also untenable. It is opposed, for instance, by the fact that so great a quantity of antivenene as ·42 cc., or nearly ½ of a cubic centimetre per kilogramme is required to prevent death when given thirty minutes before a lethal dose of venom, whereas, for the same dose of venom, only ·0004 cc. or the 1/2500th part of a cubic centimetre, or nearly the 1/000th part of the former dose is sufficient, when it is mixed with the venom before administration, and in circumstances, therefore, which are much less favourable for the production by the antivenene of this supposed increase in the resistance of the tissues.

As I have already pointed out, however, a chemical theory, implying a reaction between antivenene and venom, which results in a neutralisation of the toxic activities of the venom, is entirely compatible with the observed facts.

The experiments which I have described to-night indicate that, with some limitations in the largest quantities, the greater

the quantity of venom that has been introduced into the body in the process of producing protection, the greater is the antivenomous power of the blood-serum, and therefore the larger is the production of the antivenene. While not an actual proof, this circumstance is at the same time in harmony with the supposition that the antivenene may actually be a constituent of the venom itself. The difficulties encountered in the separation by chemical methods of the several constituents of venom are so great, that it is not probable that the only proof or disproof of this supposition will soon be obtained by chemical analysis. Some physiological experiments which I have made seem, however, to go a long way in supplying the demonstration, which in the meantime has not been obtained from chemistry.

With the object of determining, in the first place, if the still disputed statement is correct that serpents' venom is inert, or nearly so, when introduced into the stomach of an animal, cobra venom was administered, in a series of gradually increasing doses, to a cat, until finally it had received a single dose eighty times larger than the minimum-lethal; and to each of six white rats, single doses corresponding to 10, 20, 40, 300, 600, and 1000 times the minimum-lethal, if given by subcutaneous injection. Although no poisonous symptoms were produced in the animals by even the largest of these enormous quantities, it was found that the cat had so far been protected, that it could afterwards receive, by subcutaneous injection, one-and-a-half the minimum-lethal dose of cobra venom, without any other injury than some localised irritation at the seat of injection; and that the white rat, into whose stomach 1000 times the minimum-lethal dose had been introduced by one administration, survived perfectly, when seven days afterwards slightly more than the minimum-lethal dose of venom was injected under the skin.

It was also found that the blood-serum of the cat was definitely antivenomous, and the curious further fact was ascertained that her progeny had acquired protection through the milk supplied by the protected mother, thus supplying a scientific foundation for a half-admitted conviction, expressed by Wendell Holmes throughout his "Romance of Destiny," in regard to the heroine Elsie Venner.

These significant facts have been extended in a number of other experiments on white rats. In one group of experiments, each animal received, by stomach administration, 500 times the minimum-lethal, if given subcutaneously; and, as before, no toxic symptoms were observed. On the day following this administration, three of the animals received subcutaneously one-and-a-half the minimum lethal dose of the same cobra venom, and they all recovered. In one of the other three animals, however, death was caused by this dose, when it was injected only three hours after the stomach administration; in a second, when this dose was injected two days after the stomach administration; and in the third, when nearly twice the minimum-lethal was injected twenty-four hours after the stomach administration.

In a second group of experiments, a dose of cobra venom equivalent to 1000 times the minimum-lethal by subcutaneous injection was introduced into the stomach. On several occasions in which this had been done, an injection under the skin of one-and-a-half the minimum-lethal dose of venom made, in some experiments, two days, and in others three days afterwards, resulted in the recovery of the animals. As was anticipated, this large quantity introduced into the stomach, conferred immunity against only certain lethal doses of venom, and, for each lethal dose capable of being rendered innocuous, only within certain definable intervals of time.

The extraordinary result was thus obtained that serpents' venom introduced into the stomach in large quantity—in a quantity, which if injected under the skin would be sufficient to kill 1000 animals of the same species and weight—while it failed to produce any definite symptoms of poisoning, nevertheless produced complete protection against the lethal effect of doses of venom more than sufficient to kill the animals. There is a probable significance, further, in the general resemblance between the results of these experiments and those already described in which antivenene, and not venom, was introduced into the stomach. The bearing of these facts is obvious upon discussions relating to the production of immunisation against the toxines of diseases and to the origin of the antidotal qualities of the blood-serum used in their treatment. It is difficult to account for them otherwise than by supposing that the venom while in the stomach had been subjected to a process of analysis, by which the constituents which are poisonous had failed to be absorbed into the blood, or had been destroyed in the stomach or upper part of the alimentary canal, while the constituent or constituents which are antivenomous, or rather antidotal, had passed into the blood, in sufficient quantity to protect the animals against otherwise lethal administrations of venom. I confidently anticipate that this natural process of analysis will, by-and-by, be successfully repeated outside of the body by chemical methods.

It is further to be observed that by stomach administrations a degree of protection was acquired in a few hours against lethal doses, such as cannot be attained until after the lapse of several weeks by the method of injecting under the skin a succession of gradually increasing doses of venom. In circumstances, which are no doubt exceptional, the application of this method may therefore acquire some practical value.

Early this evening, I had occasion to point out that the leading facts connected with immunisation or protection, now being advanced as scientific novelties, had apparently been ascertained and practically applied for centuries by savage and uncultured tribes and sects in various parts of the world. In regard to the results I have last described, also, I discover that I have been anticipated by a long-existing and even now prevailing practice of unlearned savages. I have found in the *Lancet* of 1886, an interesting note by Mr. Alford Bolton, containing the following: "The most deadly snakes here are the puff-adders, the yellow cobra capellas, the horn-snakes, and the night-adders. Whilst frequently hearing of horses and cattle rapidly succumbing to the bites of these snakes, it appeared strange that the natives themselves, who mostly ramble about the Veldt almost naked, seldom or never appeared to suffer any further inconvenience from the bites of poisonous snakes than would be usual from any accident which would cause a local inflammation; and, on close inquiry, I found that the natives in Bushmanland, Namaqualand, Dumaraland, and the Kalakari, are in the habit of extracting the poison-gland from the snake immediately it is killed, squeezing it into their mouths, and drinking the secretion, and that they thereby appear to acquire absolute immunity from the effects of snake-bites." He proceeds to describe the native treatment of snake-bite, and then adds: "Having a month ago seen a native named Snellsteve, who is a snake-poison drinker and collector, put his hand into a box containing two yellow cobras, and several horn- and night-adders, in doing which he was severely bitten, and has never since suffered anything more than a little pain, such as might be caused by any trivial mishap, I feel I can no longer refuse to believe in the efficacy of the snake virus itself as a remedy against snake-poison." Among several communications which I have recently received on the subject, is one from Dr. Knobel, of Pretoria, who writes that when a boy he came into frequent association with a Bushman shepherd, who informed him that he had for years been in the habit of swallowing small quantities of the dried venom-glands of serpents, and he averred that by doing so he obtained protection against serpents' bites, for he had often been bitten without any other ill-effect than that an irritable wound was produced. He stated that the swallowed venom of the cobra produced greater protection than the venoms of less poisonous serpents; and that not only was this benefit produced by the swallowing of venom, but that there was also produced an exciting intoxication, differing from that of Indian hemp in so far that the venom always produced the same degree of intoxication with a definite quantity, however frequently it was taken, while the effects of the Indian hemp were gradually lessened by repetition. Another correspondent, Dr. Laurence, of Cape Colony, writes that a Kaffir boy, "aged about twenty-five years, frequently brings me for sale snakes of all kinds. . . . I have frequently seen this boy take hold of some most deadly snakes, especially the well-known puff-adder, which he will allow to bite him with impunity. Yesterday, I obtained from him what he states as the reason why the poison did not harm him. When a little boy, while walking in the Veldt, a puff-adder fastened on his leg. He shook it off, calling to his father, who a few minutes after killed the puff-adder and removed the poison glands. He then made small paper pellets and dipped them in the poison, and administered one occasionally to the boy, who stated that that cured him. He expressed his willingness to let any snake bite him." Several other letters I have received describe similar events, and also confirm the statement of Dr. Knobel, that serpents' venom produces intoxicating effects in man, evidences of which have been observed in many of the experiments made by me on the lower animals.

The results of the experiments in which the venom was introduced into the stomach, probably also afford an explanation of the protection enjoyed by certain snake-charmers, as well as by other individuals who claim to be protected, whether members of special sects or not; for although inoculation of the venom is apparently sometimes practised by them, and protection is no doubt assisted and maintained by the bites, which with impunity they frequently receive, they are known also to swallow the venom or the dried poison-glands containing it.

These experiments also seem to throw a new light upon the clearly established protection possessed by venomous serpents against their own venom. They suggested the importance of determining if the blood-serum of venomous serpents contains, as does that of artificially protected animals, an actual substance possessing antivenomous properties.

In order to arrive at some definite conclusions on this subject, I last year obtained from India several living specimens of the Hamadryad (*Ophiophagus elaps*), a serpent of greater size and more aggressive disposition than the cobra, and reputed to be as deadly as it. From the blood of several of these serpents a serum was separated, which when dried gave a product having the same physical characters as the antivenene from artificially protected animals. It was tested against cobra venom, both when mixed with rather more than a minimum-lethal dose, and also when injected thirty minutes after this lethal dose of cobra venom. In the former case, ·25 cc. per kilogramme of this natural antivenene prevented death; and, indeed, so perfectly antagonised this certainly lethal dose that no decided symptoms of poisoning were manifested. In the latter case, 5 cc. per kilogramme was found to be a sufficient quantity to prevent death. I hope by-and-by to extend these observations by testing the antidotal power of this serum against the venom of the actual Hamadryads from whose blood it had been separated.

A determination of this kind has, however, been made with the blood-serum and venom of the Australian black snake (*Pseudechis porphyriacus*), a deadly serpent whose bite produces intense destructive changes, not only at the place where it has been inflicted, but also in the blood and in many of the organs of the body. When the blood-serum and the venom of this serpent were mixed together outside of the body, and then injected under the skin of a rabbit, it was found that half a cubic centimetre per kilogramme of the blood-serum was sufficient to prevent death from rather more than the minimum-lethal dose of venom.

Notwithstanding the obliging co-operation of the India Office, I have not yet succeeded in obtaining the blood-serum of the cobra, but it may safely be anticipated that it also will be found to possess antivenomous properties.

It has thus been shown that venomous serpents themselves possess a definite substance in the blood-serum which is capable of protecting them against their own venom, and the venom of other serpents. The results of the experiments made by stomach administration of venom, supply at the same time an explanation of one, at least, of the methods by which this substance is introduced into the blood. This natural antivenene, however, is apparently not so powerfully antidotal as the antivenene obtained by the process of artificial protection.

The foregoing statements, although referring mainly to observations on the lower animals, have, probably in every particular, a very direct bearing upon both the prophylaxis and treatment of snake-poisoning in man.

Some little consideration of the details of the application of the antivenene and the employment of auxiliary measures may, however, be serviceable; and, equally of practical service, some consideration of the probable limitations to the capacity of antivenene as an antidote.

In the meantime, I cannot adduce any actual experience of its use in human beings, as although a considerable quantity, both in the liquid and dry state, was last summer sent to India, and a smaller quantity to Africa, no opportunity for using it as an antidote has as yet occurred in the districts to which it had been sent.

But, first, let me say in regard to the altogether unsatisfactory experience of the use of medicines, ordinarily so-called, that I am not prepared to take the extreme position that no good can be done by their employment. While the evidence shows that no one of the very large number of those that have been recommended as antidotes is able, in any conditions of administration, to prevent death after the reception of even the smallest lethal dose of venom, it still may be that, by the physiological effects which they produce, they may assist any efficient antidote, such as antivenene, in preventing death; and also, by prolonging life, increase the opportunity for a more thorough use of this antidote. In this category I would especially place medicines which increase excretion, such as diaphoritics and diuretics; many of the rapidly acting stimulants of the circulation, such as alcohol and the old snake remedy, ammonia; and stimulants of respiration, such as atropine and strychnine, the latter of which is enthusiastically championed by Dr. A. Mueller, of Sydney. And not only medicines, but also any measures that are available for these purposes, including artificial respiration, so distinctly indicated as a probably valuable therapeutical application in snake-bite by Fayrer and Brunton, which, though shown by the Indian Snake Commission to be incapable of preventing death when alone trusted to, was also shown to possess the valuable auxiliary power of prolonging life.

The first measure, however, that is usually and properly taken in the treatment of snake-bite, is to restrict, as far as possible, the absorption of the venom into the blood-vessels, from the place into which it has been injected by the poison-fangs, by separating this part from the more central parts of the body by a tight ligature. The efficiency of this measure, preventive rather than curative, is fortunately aided by the circumstance that snake-bites are most usually inflicted at parts to which a ligature can conveniently be applied; for in fifty-four cases collected by Wall, the part in nearly 89 per cent. of the cases was on the arms or legs. The ligature having been applied, whenever it is possible to do so, the next measure to adopt is to open up with a knife, to a considerable depth, the minute though deep punctures made by the fangs, and then to apply suction to the wound. Justification is found for this procedure in the fact, demonstrated by experiment, that notwithstanding the rapidity with which venom may be absorbed, a portion of it still remains for a considerable time in the tissues immediately surrounding the wound. This has been clearly demonstrated by both Kaufmann and Wall. The suction may be produced by the mouth, and in the absence of more effective apparatus this ready method would be serviceable, while it is attended with danger to the operator only in the infrequent occurrence of fissures or abrasions of the mouth. It is, however, more effectively and without any risk accomplished by a suction pump, such as the most useful pump invented by Mr. Andrew Smith, of Cape Colony, which I now show.

These steps having been taken, antivenene should be injected into the tissues at and near the wound and, also, under the skin above the ligature, and the ligature should not be removed until at least half an hour after a sufficient quantity of antivenene has been injected under the skin above it.

But the important question has yet to be answered, What is a sufficient quantity? The whole tenour of my remarks to-night has been to show how necessary it is to bear in mind that there is a definite relationship between the dose of venom received and the dose of antivenene required to antagonise it, and that this relationship also varies with the conditions of the administration of the antivenene, and, especially, with the interval of time that elapses between the reception of the venom and the administration of the antivenene.

In snake-bite in man it is impossible to estimate the dose of venom which has been injected, for the nature of the symptoms in the patient cannot give the information even approximately. In searching for a solution of this problem, several facts may be taken into consideration from which assistance may be obtained. And, firstly, what is the probable quantity of venom that a serpent injects into a wound? Some data for answering this question have, very kindly, been obtained for me by Brigade-Surgeon Lieut.-Colonel Cunningham, of Calcutta. Taking nine adult cobras, healthy and vigorous, he collected from each the venom ejected at a single bite, dried and weighed each collection separately, and sent me the weights. They are as follows;—

(1) 0·726 gramme.	(6) 0·113 gramme.
(2) 0·262 ,,	(7) 0·239 ,,
(3) 0·115 ,,	(8) 0·306 ,,
(4) 0·144 ,,	(9) 0·253 ,,
(5) 0·132 ,,	

The total venoms yield an average of 0·255 gramme for each bite; but, if the exceptionally large quantity stated in the first figure be excluded, the average for the remaining eight becomes ·195 gramme. It must also be considered that these quantities

were obtained in the most favourable conditions for securing the total quantity ejected at a single bite, whereas in actual practice the conditions are less favourable for the insertion of the total available venom into the tissues of the victim.

Reverting now to determinations of the minimum-lethal dose for the lower animals, we find that if the minimum-lethal dose for the cat be adopted as being the same as that for man, the total quantity of dry cobra-venom required to kill a man of ten stones weight would be ·317 gramme, which is considerably more than the quantity, judging from the above averages, that a cobra is usually able to eject during a single bite. It would therefore appear necessary to assume that the minimum-lethal dose per kilogramme for man is smaller than for a cat; but, as it is probably greater than for a rabbit, we may for convenience assume that it is twice that dose. In this case, the smallest quantity required to produce death in a man of ten stones would be about ·0317 gramme, which, however, seems to be considerably less than the quantity which a fresh cobra has at its disposal. Applying now the facts that have been stated in the series of experiments where the smallest quantity of antivenene required to prevent death when injected thirty minutes after twice the minimum-lethal dose was determined, it will be recollected that that quantity is 5 cc. per kilogramme of animal. Taking this as a basis for the dose of antivenene, in order to prevent death in man from the estimated minimum-lethal dose of cobra-venom, so considerable a quantity as 330 cc., or about 11½ ounces, of antivenene would be required, if the antivenene be injected not much longer than thirty minutes after the bite had been inflicted. This, though a large, is by no means an impossible dose, and it could, without much inconvenience, be introduced under the skin at several parts of the body.

On the other hand, the estimate which I have adopted of the minimum-lethal dose for man may be too high a one, and if it should prove to be nearer that for the rabbit, then the quantity of antivenene required to prevent death, if administered half an hour after the snake-bite, would be reduced to about four ounces. It is also to be recollected that if dry antivenene be used, it may be dissolved in a much smaller quantity of liquid than is required to restore it to its original bulk.

As to the probability, in a fatal snake-bite, of the quantity of venom received by the victim being only about, and not much in excess of, the minimum-lethal dose, it would appear that, in many cases, even so large a dose is not introduced; for general experience indicates that the majority of persons who are bitten actually recover, whatever treatment is adopted. Sir Joseph Fayrer also shows, in his classical "Thanatophidia," that in 64 per cent. of fatal cases of snake-bite in India, the victims survived the infliction of the bite for periods of from three to twenty-four hours; and this duration of life implies that the dose of venom received, could not have been much greater than the minimum-lethal.

It must be admitted, however, that even for the minimum-lethal dose of venom, the quantity of antivenene required to prevent death in man is probably inconveniently large, especially if, in the treatment, reliance is placed solely upon the administration of antivenene, to the exclusion of all or several of the auxiliary measures to which I have referred. It is desirable, also, that the antivenene treatment should be a practical one, not only for doses of venom which do not much exceed the minimum-lethal, but also for the considerably larger doses that are occasionally introduced in snake-bite.

To attain this object, further work is required in order that there may be obtained an antivenene even more powerful than that whose antidotal capabilities I have described.

I am not sanguine that this will be accomplished by carrying to a higher degree the process of artificial protection in animals. A comparison of the antivenene of rabbits which had last received thirty times the minimum-lethal dose of cobra venom with that of other rabbits which had last received fifty times that dose, has shown that the latter has but little antidotal advantage over the former, and has suggested that, in the process of artificial protection, the saturation point of the blood for antivenene is reached before the possible maximum non-fatal dose of venom has been administered.

I would anticipate with more hope the results of endeavours to separate the true antivenomous principles from the inert constituents of the blood-serum with which they are mixed; and although the required chemical manipulations are attended with many difficulties, some success has already been obtained in effecting this separation.

In the foregoing remarks, it has, however, been shown that even with the antivenene whose properties have been described, human life may be saved in a considerable, if not in a large, proportion of the cases of snake-bite, which would otherwise terminate in death. The attainment of this result is a satisfactory one; for the mortality from snake-bite is large, and is not restricted to the 20,000 deaths which annually occur in India, but includes additional thousands in all the tropical and sub-tropical regions of the world.

THOMAS R. FRASER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Drapers' Company have voted £50 to Mr. Percy Williams, a student at University College, London, towards paying his expenses of post-graduate study. Mr. Williams was placed first in honours in his chosen faculty at the B.Sc. Examination of last year in connection with the London University.

IT is stated that the total subscriptions promised for the new building fund of the University College of South Wales and Monmouthshire amounts to over £16,000. The Treasury has authorised the payment of £10,000 to the building fund, this being half the sum promised by her Majesty's Treasury on condition that £20,000 was collected in South Wales and Monmouthshire by July next.

THE University of Utrecht will celebrate its "260th lustrum" during the month of June next. The occasion will be rendered specially interesting by the *fêtes* which will be given by the students, and which will include their traditional masquerade and an elaborate old world tournament. It is expected that the ancient city will be visited by numerous strangers during the commemoration.

A MUNICIPAL school of science and art was opened at Bideford on Wednesday, April 15. For some time past instruction in science and art has been given with great difficulty in ill-fitted and unsuitable rooms. The cost of the new school will be about £3000, towards which the County Council have contributed £500 (with a promise of £75 towards science apparatus), the Science and Art Department will grant £650, and a penny rate has yielded £700.

WE learn from the *Athenæum* that the Committee of the Aberdeen University Council, which has been considering measures for the extension and better endowment of the university, has issued a report enumerating, "among its more pressing wants," the enlargement of the library, laboratory, and museums, a botanic garden, residential halls for both sexes, seven new professorships, and fifteen lectureships. The report also advises the establishment of an Aberdeen University Association, on the model of the Edinburgh Association.

ON Tuesday, April 14, the Right Hon. Sir William Hart-Dyke visited Bath and opened the northern wing of the new municipal buildings which has been appropriated to the purpose of technical schools. The building, which cost £30,000, was commenced about eighteen months ago, and comprises four floors. The basement consists of workshops and mechanical and electrical laboratories; the ground-floor includes large and small lecture-rooms, and accommodation for the library and lecturers' and director's rooms. The first-floor constitutes the school of art, while the second-floor contains a domestic department and chemical and physical laboratories.

A CONFERERCE on Secondary Education was opened on Tuesday in the Senate House, Cambridge, under the presidency of the Vice-Chancellor of the University. A resolution generally approving of the scheme set forth in the report of the Royal Commission on Secondary Education, and expressing a hope that legislative measures in accordance with that report would be passed, was carried by 128 to 41 votes. A resolution approving the establishment of local authorities for secondary education was also carried, after considerable discussion. Resolutions were subsequently agreed to in favour of the establishment of a separate central authority for secondary education, and of the preservation of the freedom, variety, and elasticity which have hitherto characterised secondary education in England.

THE following are among recent appointments abroad:—Dr. Paul Czermak, *privat-docent* in Physics in Gratz University, to be extraordinary professor; Mr. James Edwin Lough to be

instructor in experimental psychology in Harvard University; Dr. Charles Palache, instructor in mineralogy, and Mr. R. J. Forsythe in metallurgy and metallurgical chemistry; Baron Eötvös to be full professor of experimental physics in the University at Buda-Pesth; Dr. O. Hildebrand to be extraordinary professor of surgery in Berlin University, and Dr. Oestreich to be *privat-docent* in general and anatomical pathology; Dr. Klecki to be *privat-docent* in general and experimental pathology at Cracow.

The new Franco-Scottish Society was inaugurated in Paris last week at the Sorbonne. The objects of the Society are to bring the universities of France and Scotland into connection with each other by study in the one and the other of their respective students, to bring about intercourse between their professors and other officers, to promote historical research concerning the ancient relations between the two countries, in general by periodical meetings held in France and Scotland, and all other means, to renew, as far as possible, the bonds of sympathy between them. About forty delegates attended on behalf of the Scottish universities and interest in higher education; and on the French side, the Paris University and Upper Schools were represented by their chief authorities. Among the subjects discussed was the place of political science in higher education. The congress terminated with a banquet, at which M. Jules Simon presided, given to the Scottish guests by their French colleagues on Saturday.

Referring to the late Mr. George Holt, whose death we briefly announced a fortnight ago, the *Lancet* remarks that he took the greatest interest in University College, Liverpool—an interest substantially shown by his first subscription of £10,000 which was requisite to complete its equipment for incorporation in the Victoria University. It was in its medical school that he took a special interest, and his benefactions to it have been numerous. The chairs of Physiology and Pathology were endowed by him in the amount of £10,000 each, to which was added a further sum of £10,000, for the maintenance of laboratories in those branches of investigation. In addition to these benefactions he presented its medical faculty in 1886 with the sum of £2000 for distribution during the ten succeeding years in tutorial scholarships of the value of £100 each. He further fitted up in a complete manner Ashton Hall as a pathological and bacteriological laboratory, which is one of the most complete of its kind in this country. This does not exhaust the list of his benefactions; a further sum of £1000 was given as a donation to the college library, to be expended in annual instalments of £100. He was also a generous contributor to the maintenance fund of the college and a warm friend of education in general. Indeed, it is probably as a benefactor of University College that his name will live longest in local memory.

The Teacher's Registration Act, which was recently introduced in the House of Commons without comment, is a direct outcome of the work of the late Commission on Secondary Education. Though the Registration Council which it is proposed to establish is not exactly that suggested in the Report of the Commissioners, it will prove quite satisfactory to most of those whose interests are concerned. The Council is to consist of eighteen members—six, appointed by Her Majesty with the advice of her Privy Council; six, elected by the Universities, one by each of the following—Oxford, Cambridge, Durham, London, Victoria, and Wales. Two members chosen by registered teachers engaged otherwise than in elementary schools, two chosen by elementary teachers, and two by registered teachers generally. It is provided by the Act that no person shall be admitted to the register unless he possesses (*a*) "a degree or certificate of general attainments which is granted by some university or other body recognised for that purpose by the Council, and is accepted as satisfactory by the Council; (*b*) a certificate or diploma of adequate knowledge of the theory and practice of education and of practical efficiency in teaching, which is granted by some university or other body recognised for that purpose by the council." Teachers in elementary schools are to be admitted to the register on the same terms as those engaged in secondary schools. It is further to be enacted that if any person (*a*) "wilfully makes or causes to be made any falsification in any matter relating to any register under this Act, or (*b*) by false representation procures himself to be registered under this Act, or not being so registered fraudulently represents himself as being so registered, he shall be guilty of misdemeanour, and shall on summary conviction be liable to be imprisoned with or without hard labour for any term not exceeding twelve months." Teachers of proved attainments and competence who are at present engaged in teaching are to be admitted to the first register.

SCIENTIFIC SERIALS.

The numbers of the *Journal of Botany* for March and April are again almost entirely occupied by descriptive papers.—Mr. G. Murray describes a new species of *Caulerpa* from South Africa. A number of new fungi are described by Mr. G. Massee, including a new genus *Clypeum*, with no near affinities.

The second part of vol. vii. of Cohn's *Beiträge zur Biologie der Pflanzen* contains three papers.—Dr. O. Kirchner describes the root-tubercles of the Soja-bean, which, like those of other plants belonging to the pea-tribe, are caused by a microbe; large quantities are found imbedded in the tissue of the tubercle, and he regards them as belonging to a new species, which he names *Rhizobacterium japonicum*, found in the soil of Japan. As in other cases, the relation of the microbe to the host is a symbiotic one, enabling it to absorb into its tissues the free nitrogen of the atmosphere.—T. Rosen contributes a chapter to his *Beiträge zur Kenntniss der Pflanzen-zellen*, in an account of the nuclei and nucleoles in meristematic and sporogenous tissues. It is a very important contribution to our knowledge of the intricate phenomena connected with cell-division, and of the part played by the nucleus and its nucleoles in the process.—Dr. E. Heinricher describes the structure and function of the haustoria of the parasitic genus *Lathræa* or toothwort, especially of the two species *L. squamaria* and *L. clandestina*. From various points of structure he concludes that *Lathræa* is more nearly allied to the typical *Scrophulariaceæ* through *Rhinanthus*, than it is to the *Orobancheæ*, under which it is usually placed.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 10.—"Helium: a Gaseous Constituent of certain Minerals. Part II. Density." By William Ramsay, F.R.S.

The gas obtained from the minerals bröggerite, samarskite, and fergusonite is rich in hydrogen, but contains only an infinitesimal quantity of nitrogen; carbon dioxide and helium are also evolved, but no gas of new spectrum, even in samples not passed through the usual absorbents, soda-lime and phosphoric anhydride. From 1 gram of clèveite, 7·2 c.c. of helium is obtainable; 1 gram of bröggerite yields less than 1 c.c.; 1 gram of samarskite, about 0·6 c.c.; and 1 gram of fergusonite 1·1 c.c.

The density of the samples of gas from these various minerals appears to show small, but real differences. That from clèveite was found to be 2·205 (oxygen = 16), but Langlet found a sample from the same source to possess the density 2. The helium from bröggerite has the density 2·18; that from samarskite 2·12, and that from fergusonite 2·14. These differences are small; but as they are the means of several determinations with different preparations, and as the individual determinations differ less among themselves than the densities of specimens from different minerals, there appears ground for the supposition that helium is a mixture. The possibility of this conclusion is strengthened by the fact that the relative intensity of the lines in the spectrum of the gas from clèveite is different from that of the samples from bröggerite, samarskite, and fergusonite; and this difference, indeed, is visible without the aid of a spectroscope, for the clèveite gas has a richer shade of yellow, tending towards orange, than that from the other minerals; the colour of such samples is a purer yellow. Moreover, there are certain faint lines in the blue-green in the spectrum of the clèveite gas, which have not been observed, even under the most favourable circumstances, with "end-on" tubes, in that of the gas from other sources.

The author is engaged in an attempt to separate the possible constituents of helium.

"Angular Measurement of Optic Axial Emergences." By William J. Pope.

The ordinary methods of determining the angle, α, between the direction of emergence of an optic axis into air and the normal to the crystal plate, being very inaccurate unless the plate has a highly polished surface, the author has devised a new method by which this angle, α, can be determined to within 2 or 3 minutes of arc. The crystal is mounted in the Fuess axial angle apparatus, and a reading taken for the air emergence of the optic axis; a cell containing oil of known refractive index, μ, is then brought up round the crystal plate, and a new reading taken for the oil emergence of the optic axis. From the difference of the two angular readings, $\alpha - \theta$, the angle α may be calculated from either of the formulæ

$$\cot \alpha = \cot (\alpha - \theta) - 1/\mu \sin (\alpha - \theta)$$

or

$$\tan (\alpha + \theta)/2 = \mu + 1/\mu - 1 \tan (\alpha - \theta)/2.$$

Series of test measurements are given, proving the efficacy of the method; when α is 53° 24′, and μ is 1 6473, the measured value of $\alpha - \theta$ is 24° 15′, a fairly large angle. Oil of the highest attainable index of refraction should be used in order to obtain maximum values of $\alpha - \theta$; the refractive indices are conveniently determined by aid of the Pulfrich total-refractometer.

March 26.—"Additional Report on Erect Trees containing Animal Remains in the Coal Formation of Nova Scotia." By Sir J. William Dawson, F.R.S.

Linnean Society, April 2.—Mr. J. G. Baker, F.R.S., Vice-President in the chair.—On behalf of Dr. F. Arnold, of Munich, the Secretary exhibited several photographs of typical lichens, received in continuation of a series which has been for some time past in course of issue by that well-known lichenologist.—Mr. M. F. Woodward exhibited a very young example of the "Spiny Ant-eater," *Echidna aculeata*, taken from the mammary pouch of the parent at Newcastle, Western Australia, by Mr. H. B. Woodward, Curator of the Perth Museum. It was intermediate in size between two stages described by Prof. Parker, but showed no trace of the calcaneal spur characteristic of the male, nor any trace of the mammary pouch peculiar to the female. He called attention to the flattened and beak-like character of the snout and the vestiges of the "egg-breaker," and to the disposition of the spine papillæ. For the purpose of comparison, Mr. Woodward exhibited also the heads of *Ornithorhynchus* and *Echidna*, and a male and female mammary fœtus of *Perameles*.—A paper was read by Mr. C. H. Wright, "On the Genus *Stemona*, Lour.," one of the few monocotyledonous genera whose flowers are constructed on a tetramerous type, and remarkable for the diversity of its vegetative characters, while its floral structure varies between comparatively narrow limits.—Lieut.-Colonel C. T. Bingham, in a paper on some exotic fossorial Hymenoptera in the British Museum (communicated on his behalf by Mr. W. F. Kirby), enumerated thirty-four species, of which no less than thirty were previously undescribed. The discovery of many of these was due to the researches of the author, who had spent twelve years collecting in Sikkim, Burma, and Tenasserim.—The President then gave a descriptive account of the Khasia Hills from personal experience, dwelling on their geological formation, the extraordinary rainfall of the district (120 inches in five days), and the chief characteristic features of the flora and fauna.

Royal Meteorological Society, April 15.—Mr. E. Mawley, President, in the chair.—Mr. W. Ellis, F.R.S., read a paper on the mean amount of cloud on each day of the year at the Royal Observatory, Greenwich, on the average of the fifty years 1841–90, in which he showed that a principal maximum occurs in winter and a principal minimum in autumn, with a secondary much less pronounced maximum in summer and a secondary minimum in spring. There is, however, considerable irregularity in the succession of daily values, the differences between which on consecutive days are in numerous cases relatively large. Cloudless days are most numerous in spring and autumn, and least so in winter and summer; days of little cloud are somewhat less numerous in winter as compared with other parts of the year, whilst days of medium cloud are much more numerous in summer than in winter. Days of much cloud are nearly equal in amount in all parts of the year; whilst overcast days are much more numerous and nearly equal in amount in the first and fourth quarters of the year, much less numerous in the second quarter, and again less numerous in the third quarter.—Mr. E. D. Fridlander gave an account of some observations of the amount of dust in the atmosphere made at various places during a voyage round the world in 1894–95. The experiments, which were made with a form of Aitken's pocket dust counter, showed that there are often considerable variations in the number of dust particles in a very short space of time. Not only did dust occur in the air of inhabited countries, over the water surfaces immediately adjoining them, and up to an altitude of 6000 or 7000 feet amongst the Alps, but it was also found in the open ocean, and that so far away from any land as to preclude the possibility of artificial pollution, and its existence has been directly demonstrated at a height of more than 13,000 feet.—Major H. E. Rawson gave an analysis of the Greenwich rainfall records from 1879 to 1890, with special reference to the declination of the sun and moon.

EDINBURGH.

Royal Society, April 6.—Rev. Prof. Flint in the chair.—A communication by Drs. Stewart and Young, of the Public Health Laboratory, Edinburgh University, on the bacteria in milk as supplied in Edinburgh, and the relative efficiency of different methods for their removal, was read by the former. Since 1894, samples of milk from dairies all over the town had been examined, and it was found that bacteria were most numerous between July and October. The milk from dairies with cowhouses in town contained, five hours after milking, more than eight times the number of micro-organisms in milk from dairies supplied from the country. Methods for sterilising were described, but each imparted a boiled taste to the milk. Scalding, at 176° F., would keep the milk sterile for twenty-four hours if great care were taken, but when performed on a large scale there could be no guarantee, owing to possible post-scalding contamination, that the bacillus of tubercle and diphtheria were not present.—Dr. J. Macintyre, Glasgow, indicated some new results which he had got with the Röntgen X-rays. He described his methods for reducing exposure and obtaining definition, and exhibited photographs of different parts of the skeleton of the living subject. Among these were that of one side of the head, obtained by putting the tube so near the other side that its image was eliminated, the sternum and ribs, and the vertebral column with scapula and clavicle. Dr. Macintyre described screens of different kinds which he had made, of which the one saturated with barium platinocyanide was the best. He suggested the use in surgery of fluorescent screens for the cavities, such as the mouth, throat, and maxillary antrum, and exhibited the result of an attempt at photographing tissue. In the kidney, from a cadaver shown, the distinctive in structure of the different parts, and the presence of a calculus, were quite apparent.—Dr. W. G. Aitchison Robertson read a summary of an investigation regarding the digestion of starch in the stomach. He showed under what conditions, normal and abnormal, amylolysis ceases in the stomach, and the effect which the gastric secretion has on the ferment ptyalin.—A communication from Lord Kelvin on impulsive fluid motion was held as read.

PARIS.

Academy of Sciences, April 15.—M. A. Cornu in the chair.—On fallow ground, by M. P. P. Dehérain. The ancient practice of allowing land to lie a year fallow after three years cultivation is shown to have rested upon a sound basis, the land increasing considerably in nitric nitrogen during the fallow year. With modern manures the necessity for this no longer exists, although the practice still survives in many parts of Europe.—Nitrates in spring water, by M. T. Schlœsing.—On a letter from Gauss, of date June 16, 1805, by M. de Jonquières. The letter was written to M. Delisle, Professor of Mathematics at Orleans.—On the products of combustion of an acetylene burner. Explosive mixtures of acetylene and air, by M. N. Gréhant. The combustion of acetylene in an ordinary fish-tail burner is complete, the products not comprising the least trace of a combustible gas containing carbon. With mixtures of acetylene and air the most violent explosion was produced when the volume of air was nine times that of the acetylene.—On certain classes of Laplacian equations with equal invariants, by M. A. Thybaut.—Verification of Kerr's law in absolute measure, by M. Jules Lemoine. By the use of a condenser having carbon disulphide as the dielectric, with potentials varying from 5000

to 35,000 volts, Kerr's law was found to be correct to within at least 1 per cent. The absolute value of the constant for carbon bisulphide is $3 \cdot 7 \times 10^{-7}$.—On electrified Röntgen rays, by M. A. Lafay. A verification of results previously published. It was found that it was a matter of indifference, in deviating the Röntgen rays, whether they were electrified before or after traversing the magnetic field.—The action of the Röntgen rays upon double and triple electric layers, by M. N. Piltschikoff. The rays discharge the double electric layer very slowly, if at all.—On the mechanical action emanating from Crookes' tubes, by MM. A. Fontana and A. Umani. A claim for priority.—Application of photography by the Röntgen rays to analytical researches on vegetable materials, by M. F. Ranwez. The adulteration of vegetable products with mineral substances, such as saffron with barium sulphate, is readily detected by the differences in the shadows cast by the X-rays.—On homolinalool and on the constitution of licareol and licarhodol, by MM. Ph. Barbier and L. Bouveault.—Action of the sodio-cyanacetates of propyl, butyl, and amyl upon diazobenzene chloride, by M. G. Favrel. The hydrazones obtained exist in two isomeric modifications, distinguishable by their melting points.—On the diurnal lunar wave and on the secular variation of the barometer, by M. P. Garrigou-Lagrange. The action of the moon on the atmosphere is well marked. On the tenth parallel of latitude, the waves caused by the moon may amount to 1·2 mm. of mercury.—On the principal results of the last ascent to a great height of the balloon *Aerophile* (March 22 1895), by MM. G. Hermite and G. Besançon. At a height of eight and a half miles the minimum temperature recorded was $-63°$ C., or a fall of $1°$ per ·597 feet.—Animal temperatures in the problems of evolution, by M. Quinton. The temperatures prevailing on the globe in the remote past were higher than at present, owing to the gradual cooling of the globe. An animal whose life process was in equilibrium with a given temperature when the temperature commences to fall, must do one of two things—either adapt its chemical and physiological changes to the surrounding temperature, as in the case of the pepsin of a reptile, which will act on a food at temperatures near 0°, or may tend to artificially maintain the temperature of the body, by developing heat. Thus in one group of animals, whose evolution had ceased before appreciable cooling had set in, the greater the antiquity the smaller ought to be their power of developing heat. With animals, on the contrary, whose evolution had been prolonged into the cold ages, the reverse would be the case, the body temperature being the lower, the older the animals. Experimental figures confirm these theoretical reductions.

Berlin.

Physical Society, March 13.—Prof. von Bezold, President, in the chair.—Dr. Lindau, of Munich, spoke on the cooling of gases during their adiabatic expansion, and showed that from this the specific heat of the gases may be determined. In opposition to this view Prof. Planck pointed out that the cooling does not depend solely on specific heat, but also on the extent to which the gas differs from the condition of a perfect gas.—Dr. Orlich demonstrated how every phasic variation of alternating currents may be shown by means of two of Rubens' vibration-galvanometers placed at right-angles to each other. He intends to carry out further experiments in order to see whether the variations are measurable by this method.—Prof. A. König made a communication on the absorption spectra of visual purple from various vertebrates, and on visual yellow, which he had only once been able to investigate as obtained from the visual purple of a human retina, whereas the visual purple of other vertebrates never yielded visual yellow. He hoped to be able to control this single observation, should the chance of so doing present itself.

March 27.—Prof Warburg, President, in the chair.—Mr. Archenholz reported on his experiments with a view to testing the statements of Le Bon as to black light. He showed how great is the difficulty of completely excluding all lateral light even by using metallic screens, and exhibited photographs in support of this, and came finally to the conclusion that Le Bon's black light is merely a false light. Experiments made with Balmain's material on the permeability of wood and metal by phosphorescent rays were similarly negative.—Prof. Goldstein spoke on the means for increasing the intensity of Röntgen X-rays, of which he mentioned two. The first consists in using the rays which are emitted forwards by the phosphorescent substances, since they are much more intense than those that have passed through the substances. The second consists in the employment of potassium platinocyanide, which emits a blue light acting very rapidly on photographic plates. Further, a plate had recently been prepared by Siemens and Halske, which gives a clear image of the hand in a few seconds by Röntgen's rays, and finally Kahlbaum has prepared a barium platinocyanide which similarly materially shortens the necessary exposure.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Treatment of Phthisis: Dr. A. Ransome (Smith, Elder).—Handbook for the Bio-chemical Laboratory: Prof. J. A. Mandel (Chapman).—A Compendium of General Botany: Dr. M. Westermaier (Chapman).—Modern Stone-Cutting and Masonry: J. S. Siebert and F C. Biggin (Chapman).—Meteorological Observations made at the Adelaide Observatory, &c., 1891, 1892, 1893 (Adelaide).—The Water Supply of the City of New York, 1658-1895: E. Wegmann (Chapman).—The U.S. Public Works: Captain W. M. Black (Chapman).—Cholera in Indian Cantonments, and how to deal with it: E. H. Hankin (Cambridge, Deighton).—James Clerk Maxwell and Modern Physics: R. T. Glazebrook (Cassell).—An Elementary Treatise on the Calculus for Engineering Students: J. Graham (Spon).—Les Tramways: R. Seguela (Paris, Gauthier-Villars).—Astronomie, Astrophysique, Géodésie, Topographie et Photogrammétrie: G. Towne, 2 Vols. (Paris, Bertaux).

Pamphlets.—Medical Inspection of, and Physical Education in, Schools: C. Roberts (Bale).—Weitere Ausführungen über den Bau der Cyanophyceen und Bacterien: Prof. O. Bütschli (Leipzig, Engelmann).—Stonyhurst College Observatory. Results of Meteorological and Magnetical Observations, 1895: Rev. W. Sidgreaves (Clitheroe).—Colonial Origins of New England Senates: F. L. Riley (Baltimore).—Licht-, Elektricitäts- and X-Strahlen: R. Mewes (Berlin, Krayn).—Die Fortpflanzungs-Geschwindigkeit der Schwerkraftstrahlen: R. Mewes (Berlin, Krayn).

Serials.—Proceedings of the Physical Society of London, Vol. xiv. Part 4 (Taylor).—Journal of Anatomy and Physiology, April (Griffin).—Royal Natural History, Part 30 (Warne).—Journal of the Chemical Society, April (Gurney).—Journal of the Institution of Electrical Engineers, April (Spon).—Microscopical Studies in Botany, March (Jersey, Hornell).—Mind, April (Williams).—Contributions from the U.S. National Herbarium, Vol. iii. No. 7 (Washington).—American Journal of Mathematics, Vol. xviii. No. 2 (Baltimore).—Internationales Archiv für Ethnographie, Band ix. Heft 2 (Leiden, Brill).

CONTENTS.

THURSDAY, APRIL 30, 1896.

THE INTELLECTUAL RISE IN ELECTRICITY.

The Intellectual Rise in Electricity: a History. By Park Benjamin, Ph.D., LL.B., Member of the American Institute of Electrical Engineers. Pp. (with index) 611. (London: Longmans, Green, and Co., 1895.)

SINCE the days of the distinguished Joseph Priestley, no physicist has ventured to give us series of lessons on the history of the origin and progress of electrical science. In a large and admirable volume entitled "Priestley on Electricity" the author of it tried to introduce everything that was known up to his own time, and he is a poor electrician who is not fully conversant with this gigantic labour. At last another author has risen who has undertaken to supplement preceding authors, and to put before the world in one volume the subject of "the evolution of electricity"; that is to say, to describe the history of electrical science from its origin up to the present day. The author who has undertaken this task is Dr. Park Benjamin, LL.B., a writer from the other side of the Atlantic, who, it must be said, has made himself fairly acquainted with the many electricians who have preceded him, and who makes an excellent effort to instruct the world at large by bringing into what may be called a nutshell the many pieces of information which he has been able to collect and put together in a readable form. The work is a large octavo, and consists of 611 pages, the whole being written in a style which is as commendable to the general scholar as to the particular electrician. The greatest care has been taken, step by step, to supply such illustrations as shall make the text comparatively easy. There are also portraits of men who have been engaged in the practical work of electricity; and although we would not compare the book with that written by Priestley, we must candidly say of it that all teachers, especially physical teachers, are certain to be benefited by its perusal and intimate study.

Like preceding writers, Dr. Park Benjamin, in tracing back the history of electricity, believes that in the dawn of civilisation the discovery of the force was connected with the substance commonly known as amber. The discovery of beads in the royal tombs of the Mycenæ, and at various places throughout Sardinia and the ancient territory of Etruria, proves, he says, that trade in amber existed in prehistoric times; while the identity in chemical constitution of the ornaments at Mycenæ and the Baltic amber from the tertiary formation of the Prussian Samland, the coasts of Southern Sweden, and the Northern Russian provinces, indicate the far distant source from which the resin was anciently derived. Who first brought the resin from the Baltic Sea to the Levant is an undetermined question, as it is known to have come across Europe by land as well as round the continent by water.

Giving full credit to the Phœnicians for their enterprise, and with speculations as to the mode in which amber may have travelled after its properties were first discovered, Dr. Benjamin proceeds to consider the magnet, or lodestone, and explains that the phenomena of the lodestone are two-fold: it not only attracts iron objects, but it has its polarity, or in other words exhibits its opposite effects at opposite ends, by reason of which, when in elongated form and supported so as easily to turn, it will place itself nearly in the line of a meridian of the earth, that is to say in a north and south direction. This is its attractive tendency, or as William Gilbert called it in 1600, its "verticity," and upon this duality, as is well known, depends the use of the magnetic needle in the mariners' compass. In the close of Chapter I., in which reference is specially made to the magnet and to iron as the substance upon which it acts, there is a short but sound notice of history collected from Jewish and Egyptian writers, which, though not strikingly convincing, is of unquestionable interest.

Getting lower down, Dr. Benjamin, as a matter of course, quotes Thales, who many suppose to have been the first man in the electrical field—though he lived before Christ—who understood the phenomena of magnetic attraction, on which point Dr. Benjamin remarks:

> "It must be admitted that even if Thales had been cognisant of the amber phenomenon—that is to say, the effects of rubbing amber and presenting it, in the excited state, to the bits of straw which it attracts—it was not logically necessary, from his point of view, to include it specifically under his theory based upon the attraction of the lodestone, and hence lack of mention does, on his part, not imply lack of knowledge."

Wading through pages of matter touching largely on the Chinese origin of the compass and knowledge of the Chinese in regard to the lodestone, Benjamin asserts that no recorded evidence of the attraction of the magnet or amber appears in the Chinese books of earlier date than the fourth century of our era. He follows up scientific records from the decline of the divine school of Alexandria, which followed the period of the Ptolemies, and explains that through the earlier centuries of the Christian era we find the problem dealt with again and again, sometimes purely physically, more often metaphorically; sometimes by the poets, but with greater frequency by the fathers and historians of the Church. He quotes St. Augustine on the attraction of the magnet.

> "I was thunderstruck ('vehementer inhorrui'). I saw an iron ring attracted and suspended by the stone (lodestone), and then, as if it had communicated its own property to the iron it had attracted and had made it a substance like itself, this ring was put near another and lifted it up; and as the first ring clung to the magnet so did the second ring cling to the first. A third and fourth were similarly added, so that there hung from the stone a kind of chain of rings with their hoops connected, not interlinking, but attached together by their outer surface."

Gliding along and touching on the voyages of the Northmen and the scientific writings of the Anglo-Saxons, the works of William Appulus, the Anglo-Norman magnetic knowledge, the labours of Alexander of St. Albans (Alexander Neckham), the contemporary of Richard of England, son of Henry II., Dr. Benjamin puts before us the first mariners' compass; touches on the penalty for falsifying the compass, and taking up numerous statements and stories in relation not only to

magnetic phenomena, but to the men who studied them, including the discovery of variation by Columbus, the reasonings of Paracelsus as a speculator, and the work of physicians as discoverers, he brings us at last, as a necessity, to one of our first great Englishmen, William Gilbert of Colchester. He gives a little sketch of the life of William Gilbert, puts him down amongst the Fellows of the Royal College of Physicians, and states that he began to practise in London, establishing himself in a house on St. Peter's Hill, between Upper Thames Street and Little Knightrider Street. There Gilbert became a famous man, and, as we know, became physician to Queen Elizabeth, and was, it is said, the only man to whom she left a legacy. To Gilbert, Benjamin gives, naturally, a warm introduction and note of praise, and to Gilbert's original work, "De Magnete," he assigns as much credit as could be given by any one of the members of the new society founded in honour of his name, and which wishes to establish a monument to him in his native city. He also notes Gilbert's doctrine on the subject of the magnet, with his own criticism thereupon. Gilbert seems to urge, that the direction in space is such that the north pole of the earth constantly regards the pole star, so that if that pole were turned aside from this steadfast position it would go back thereto, from which it is apparent, says Benjamin, "that this doctrine rests upon the conclusion that the earth itself is a freely movable magnet, having poles, and amenable to the same laws as the compass needle."

Gilbert is capable of many errors which Dr. Benjamin is not slow to detect; while he makes, we must admit, a very fair and just statement or analysis of the work of Gilbert, supplying plates from his "De Magnete," and is very fair in reviewing the revelations of Bacon, who recognised Gilbert's eminence as a philosopher and discoverer.

All this is extremely interesting, and a grand introduction to the science of electricity as connected with the magnet, and when we get into the account of the way in which electric action and the discovery of electric propulsion, especially in reference to the discoveries of Cabæus on the magnetic spectrum, with Descartes' observations on the magnetic field, we arrive at the definite origin of electricity amongst English philosophers and their colleagues, of many of whom Dr. Benjamin has not the same knowledge, or, at all events, does not show the same sympathies as we ourselves do. We do not all consider, although his father was executed, that Sir Kenelm Digby, for instance, was an adventurer, conspirator, naval commander, and diplomatist, as well as man of science; neither do we take the same view of Sir Thomas Browne that our author seems to have taken, while, when we come to his description of Stephen Gray, we are forced to differ from him, in regard to his estimate of him, very sincerely. According to our own view, electricity was altogether chaotic as a science until this Charter House pensioner, Stephen Gray, appeared before the world, and revealed himself through the Royal Society. It was he who discovered conduction, induction, insulation, and minor thunder and lightning, and, indeed, almost all the basic facts, without which electricity could never have become a true science.

The story about Stephen Gray is fairly told, but it is far from complete, and should have tallied better with Emerson's sentence which the author has inserted on his title-page.

"Not the fact, but so much of man as is in the fact."

Gray, indeed, was himself an evolution, small though he may seem to have been to his contemporaries, and with them was, perhaps, petulant. He was just as great as Gilbert, and in any work on electricity deserves to be put on a level with him. It was he who first truly set up the electric telegraph, and, actually, between two and three hundred years ago, sent messages by it over ground which is still laid out in the front of an old mansion, Otterden Manor, near to Faversham. It was he who died relating to Mortimer, the Secretary of the Royal Society, his conviction that there was such a thing as an electric planetarium in the universe, and it is to him and his labours that we now owe the electric light which so brilliantly illuminates our darkness.

As we glance through the copious index with which this volume is concluded, and see name after name written down, for our edification, of men who have been engaged in electrical pursuits, the temptation is very great to follow Dr. Benjamin step by step, and to inquire on what ground some men are named at length, while others—Cavallo and Fowler, for example, are omitted altogether. We are not surprised that he dwells so long and favourably on one of his own countrymen, Franklin, whom we in England do not certainly ignore, and whose electrical knowledge is probably spoken of with an enthusiasm which few electricians have received. We do not object to the admirable picture of Franklin seated at his studies, which is given to us as a prelude to the sixteenth chapter, but we do regret that there should be any omissions of other men equally careful as Franklin, equally industrious, and quite as original; but we would not be severe with an author who has natural predilections, like all of us, and who is never wanting in industry. We would rather look over every omission and every possible error, and we commend our readers to place Dr. Benjamin's volume on their shelves as a book of electrical philosophy which cannot be too often read or too seriously studied.

It has for many long years past been felt by the teacher of electrical science, and we may add, by the learner also, that the course cannot be considered complete which does not include the beginnings as well as the endings of electrical advances. It is too often felt by those who teach, that it is necessary to deal solely with what is actually going on, and we must admit that when a professor stands at the lecture table with all the modern apparatus before him, and with the hosts of modern facts at his direct command, facts which he is anxious to illustrate and demonstrate, the temptation is great for him to confine himself to the subject immediately before him, and to show how, out of simple principles, he can explain some new and important truth or line of practice. At the same time he rarely ventures on this path without omitting, in the strangest way, a great deal of that wonderful past which Dr. Benjamin has made such fine attempts to describe. Of all words, again, we like the title he has chosen—evolution. "Evolution" is as applicable to electricity as it is to man himself, and, to be

quite sincere, it must be admitted that every detail in respect to electrical developments is an evolution. It is in this way that electricity has progressed and will continue to progress, that is to say, on the bare data propounded by one man another will proceed. The one will modify experiment; will get an advanced result, and from his result the next man will take up the parable and will progress. Thus, though there may be a thousand discoveries in electricity, there will never be one prophecy; and if Dr. Benjamin's book exposes this startling truth, it has performed a duty which probably its author did not expect of it, and for which the world will be grateful.

ARTIFICIAL COLOURING MATTERS.

Traité des Matières Colorantes organiques artificielles, de leur préparation industrielle et de leurs applications. Par Léon Lefêvre. Two vols. Pp. xx + 1648. (Paris: G. Masson, 1896.)

IN the early days of the coal-tar colour industry the French chemists, Coupier, Lauth, Girard and De Laire, and others did good work in the way of investigation, and certain standard books of reference which were indispensable in their time bore the names of French authors. Then the centre of activity in this field seems to have been shifted to Germany, and for some years we have been accustomed to look to that country for new discoveries and authoritative treatises. The author of the work now under consideration, M. Léon Lefêvre, who is "Préparateur de Chimie" in the École Polytechnique, has once again set the current of coal-tar literature flowing in France, and he is to be congratulated on having produced a treatise which may, without exaggeration, be described as the most comprehensive that we have at present in any language. The two bulky volumes under notice cover the ground occupied by several distinct German works; for not only is the subject dealt with in its purely chemical aspect, but the methods of production on the large scale, and the modes of application of the various colouring matters are likewise given in detail. It is impossible in these columns to give a critical review of a technical work of this magnitude, but a general statement of the method of treatment will enable those who are interested in the subject to form an idea of the extent to which they are indebted to M. Lefêvre.

The colouring matters are classified into groups in accordance with the scheme originally adopted by Nietzki, and now familiar to all chemists who are acquainted with this branch of their science. Each group commences with a preliminary statement setting forth the history, general characters and constitutional formulæ of the compounds dealt with; then follows the description of the individual colouring matters, and afterwards a tabular summary of the whole group, from which can be seen at one glance the mode of preparation, the formula, the commercial name, the appearance and properties, and the references to the literature, patent or otherwise. Following these extremely valuable tables, there is a section on the technique, *i.e.* the method of manufacture, the processes being described in sufficient detail to be of value to technologists, and the plant being figured by well-executed cuts. The reader having thus been led up from the history of the discovery of the colouring matters to their production on the large scale by the latest and most approved methods, is then let into the mystery of the dyer's art, and is given explicit directions how each colouring matter should be applied as a tinctorial agent. With each group there is also associated a tabular scheme of the diagnostic reactions of the colouring matters on the fibre, a list of bibliographical references, and lists of patents.

It does not often fall to the lot of the reviewer of a technical work to be raised to an enthusiastic state of mind by the treatise which has been submitted to his judgment; but in the present case, it was certainly with something akin to enthusiasm that we turned over the pages of M. Lefêvre's luxurious volumes. The synopsis of the mode of treatment which we have attempted to give will show that in one work we now have the chemistry of the coal-tar colouring matters on the lines adopted by Schultz in his well-known treatise of 1887–90, the tabular synopses made familiar by the tables of Schultz and Julius, edited by Green in 1894, the technique of manufacture for which we have had to refer to such works as that by Mühlhäuser, the tinctorial characters and modes of application for which we have been in the habit of consulting special treatises on dyeing and printing, and lastly, the diagnostic reactions which are generally looked up in some work on proximate organic analysis. To say that the author has covered all this ground in a perfectly faultless manner would be to attribute to him superhuman faculties; but, with the exception of a few doubtful statements of history, we are bound to say that no serious flaw is to be found in the 1648 pages composing the work. The dyed and printed patterns on wool, silk, leather and paper, of which there are over 260 specimens, make the volumes somewhat ungainly, and would perhaps have been better collected together into a distinct supplementary volume. The thirty-one illustrations of plant are executed with that clearness for which our French colleagues are so justly celebrated, but, as is so generally the case, they suffer from the defect of having no scale of size attached. The structural formulæ occupy a very much larger amount of space than we are accustomed to here, owing to the free use of the benzene hexagon, but this is a matter of luxury and not a point for critical complaint; it must, however, have added considerably to the cost of printing.

The work is introduced to the public by a preface from the pen of M. Edouard Grimaux, Membre de l'Institut, who at the close of his remarks says:—

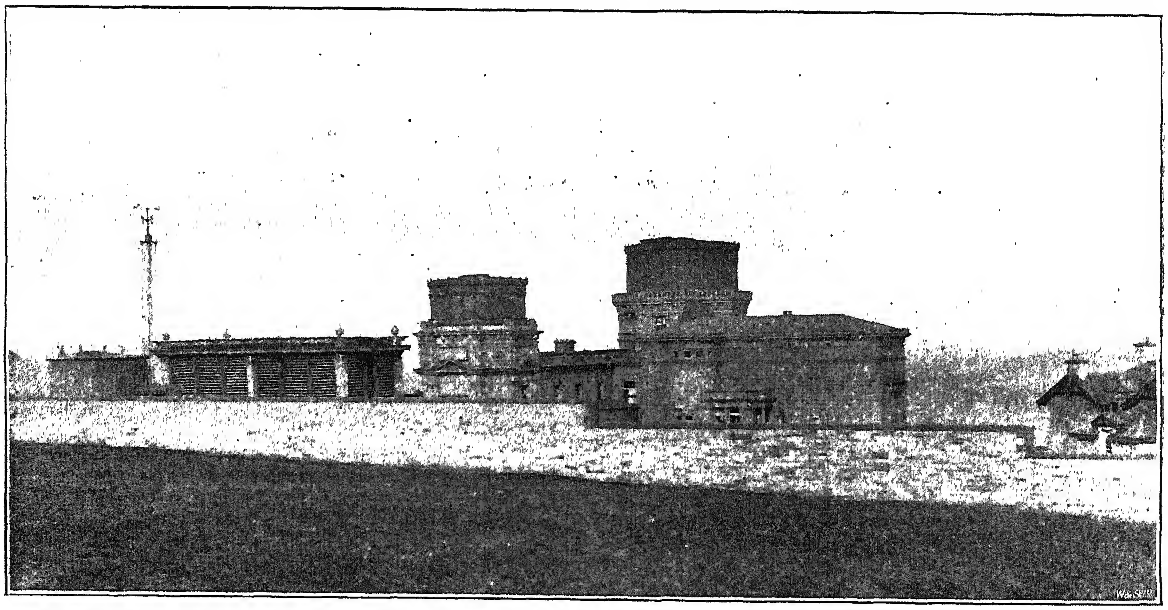
"En raison de l'intérêt que je porte à l'auteur, mon fidèle compagnon de laboratoire depuis dix années, il me serait difficile de faire l'éloge de son livre et de dire tout le bien que j'en pense; mais j'ai vu naître et continuer cet ouvrage sous mes yeux, et je puis témoigner de la conscience avec laquelle il a été fait; j'ai tout lieu d'espérer qu'il recevra du public savant l'accueil qu'il mérite."

The commendation which M. Grimaux modestly withholds may be supplied by this notice; and in directing the attention of English chemists to M. Lefêvre's treatise, we have not the least hesitation in stating that the author has succeeded in producing a coal-tar classic which must take precedence over every other work on the subject.

R. MELDOLA.

research, for which purpose a siderostat by Foucault, with a silvered mirror 16·3 inches in diameter, is mounted at the northern edge of the platform under a movable cover. Arrangements have, of course, been provided for darkening this room at pleasure. In the north wall of the room, and facing the siderostat, is fixed a massive iron frame capable of carrying lenses ranging from the 15-inch object-glass down to that of an ordinary camera, the lenses most frequently used being provided with adjustable rings so arranged that they need only be centred once for all. For 39 feet of the length of the room three lines of rails are let into the floor, on which travel three iron carriages for the spectroscopes, gratings, or cameras in use, the side rails being intended for apparatus to receive deviated rays. In addition to these a narrow gauge line runs along the centre of the room from end to end, 66 feet. This is intended for long-focus photographs. All these rails are carried by steel beams distinct from those which support the floor. Any one who has been at Dunecht will recollect the comfort with which the most delicate solar work could be carried out in the optical room there, of which the room at Edinburgh is a copy.

In the east tower is mounted the 15-inch Dunecht refractor. Amongst the adjuncts to this instrument may be mentioned the large stellar spectroscope made by T. Cooke and Sons (Fig. 2). As this spectroscope has not yet been described, the following particulars may be of interest. It is provided with three prisms: (1) one of 60° by the makers, giving a dispersion of 5° 7′ from A to H, and capable of separating the lines 488·81 and 488·84 of Angström's map. It shows also 43 lines between B and C. It was with this prism that D_3 and another helium line, 487·6 mmm. ±, were detected in the Great Nebula of Orion at Dunecht in the winter of 1886–87 (see *Monthly Notices*, vol. xlviii. p. 360). (2) A large compound prism by Sir H. Grubb, with nearly twice the dispersion of the prism first mentioned. (3) A Merz prism with an angle of 20°, intended for use on the fainter stars. The collimator has a focal length of 24 inches, and an aperture of 2 inches, the ratio being 12 to 1, the same as that of the 15-inch refractor. The viewing telescope is somewhat larger in aperture, to ensure catching the whole of the rays emerging from the prism. The tube of the collimator is made as rigid as possible, and is isolated from the large bronze tube which carries the whole spectroscope. The rays from the great object-glass may be intercepted, just in front of the slit, by a diagonal eye-piece, removable at pleasure, which allows the object to be viewed, and serves also as a finder. Attached to the same draw-tube is a second prism for throwing the light from any artificial source upon the slit. Only one prism can be used at a time, but it can be readily exchanged for another, without disturbing the adjustments. The prism is carried by a divided circle, so that its exact position is always known. The long rod shown in the figure rotates the prism; the shorter one moves the viewing telescope, the position of which may be read either by two opposite microscopes, or by a long reading microscope (not visible in the figure), carried close down to the observer's eye. The pointer in the field of view is illuminated by monochromatic light of any desired colour or intensity, produced by a small direct-vision spectroscope, on the plan devised by Prof. Smyth. No detail has been omitted that could contribute to the accuracy of the observations, such as focusing scales for collimator and viewing telescopes, eclipsing screens in the field of view as well as in front of the slit. A thermometer shows the temperature of the inside of the prism box. It will be seen from Fig. 2 that measures can be made on either side of the axial line by simply turning the viewing telescope and rotating the prism into the proper position.



6 in Refractor. Transit House. 24-inch Reflector. Siderostat. 12-inch Reflector. 15-inch Refractor. Optical Room. Library.

Fig. 1.—Royal Observatory, Edinburgh, from the South-west.

It would be scarcely possible to enumerate the various minor instruments, but the following may be mentioned. Two heliostats by Duboscq and Browning; photo-measuring instrument by Grubb; dividing engine by Dumoulin Froment, of 64 cm. range, showing the thousandth part of a millimetre; delicate Oertling balance and weights; standard mètre à 0° by Dumoulin Froment; standard yard by Simms; two excellent spherometers by

Hilger; Foucault apparatus for measuring the velocity of light; Ladd polariscope with large collection of crystals; two extra large Nicols; anemograph, King's barograph, and standard barometer by Casella; resistance coils, large electro-magnet and a great variety of electric and physical apparatus, including one of Prof. Rowland's magnificent gratings. Among the smaller telescopes are:

12-inch reflector by Browning-With,
6-inch refractor by Dallmeyer,
6 " " " T. Cooke and Sons,
4 " " " " "
3 " " " " "

All the foregoing are equatorially mounted with clockwork, and there is an object-glass prism by Merz, which fits either of the 6-inch telescopes.

A 4-inch reversible transit by Cooke and Sons, with stand for both the meridian and prime vertical, is mounted in a detached hut.

A Zöllner's astrophotometer, a 12-inch altazimuth by Simms, a variety of theodolites, sextants, reflecting

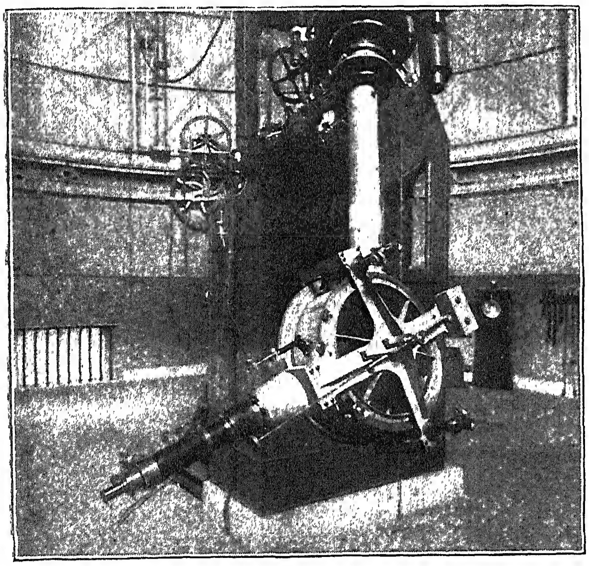


FIG. 2.—Stellar Spectroscope, by T. Cooke and Sons, attached to the 15-inch Dunecht Refractor. (The divided circle is 18 inches in diameter.)

circles, cameras, spectroscopes, and prisms from $4\frac{1}{2}$ inches downwards, complete the outfit for work at the observatory and on expeditions.

A word must be said about the clocks. Two of these, the Dunecht sidereal clock by Frodsham, and the excellent Makdougall-Brisbane clock by Dent, from Calton Hill, are mounted in the base of the pier of the larger tower, shut in by thick double doors stuffed with "slag-wool." This guarantees a nearly uniform temperature for both clocks, while the Brisbane timekeeper has the further advantage of being subjected to a uniform barometric pressure of 25 inches maintained inside a cast-iron case. This latter part of the arrangement has been most efficiently carried out by Messrs. Jas. Ritchie and Son, of Edinburgh. Automatic signals from this chamber serve to rate the mean time clock, which is kept to Greenwich time, and transmits currents to Edinburgh and Dundee for regulating the time signals.

The 8·6-inch transit circle by Troughton and Simms, formerly at Dunecht, is mounted in a detached double iron house 80 feet west of the observatory, with which it is connected by a covered way. It has two finely-divided circles—one of them movable. North and south of the instrument, but in the same room, are two 6-inch collimators, which can be pointed on each other through a hole in the $17\frac{1}{4}$-inch central cube of the telescope. The opening in the roof is 39 inches broad.

The great 4-barrelled chronograph by Cooke, from Dunecht, capable of recording six hours' continuous observations on each barrel, is mounted in the base of the west tower. It is supplemented by a small 3-pricker fillet chronograph by Fuess, of Berlin. Both instruments can be worked from six places in the observatory, and with either of the sidereal clocks. The clocks can also be compared automatically on the chronograph, or audibly by a sounder.

In the south wing the principal room is the library, 24 feet by 34 feet 6 inches, and 20 feet in height, which contains the astronomical library collected by Lord Crawford at Dunecht, comprising about 15,000 volumes. Divided amongst the computing rooms are the books removed from Calton Hill.

The observatory and instruments are lighted by electricity, generated by a 7-horse Crossley gas engine, charging 53 large storage cells.

Within the boundary wall of the observatory stand the house of the Astronomer Royal for Scotland, two semi-detached villas for assistants, and a gate-lodge for the care-taker and messenger.

The transit circle and reflector have only just been mounted, but the large refractor has been in use since last autumn, and in spite of the very unfavourable weather a considerable number of observations of comets have been secured with it. The provisionally-adopted coordinates of the transit house are: Latitude $+ 55° 55' 28''·0$. Longitude 12m. 44·2s. west of Greenwich. It is not likely that these will have to be materially altered.

THE PLACE OF SCIENCE IN EDUCATION.

THE Bishop of London should know something about education. He has been the Principal of a Training College, an Inspector of Schools, and Head Master of Rugby School, and he has written in a broad spirit on educational matters. No wonder, then, he modestly confessed at the London Diocesan Conference last week, that "he happened to know a good deal about education." There is one branch of knowledge, however, which he thinks should be cut off from the educational tree nurtured in elementary schools, and that is the branch of science. "He had very often felt," he said, referring to the Education Bill, "that it had been a very great evil that we insisted upon instructing little children in elementary schools in a great many scientific subjects, and he should not have been at all sorry if all these scientific subjects were got rid of entirely, and it had been left to the managers, and to the teachers under the managers, to introduce other subjects which would be more suitable." And, later on, he remarked: "Teaching of an advanced character might very well be permitted in some schools, but in regard to all these scientific schools, and the apparatus connected with them, the sooner they were got rid of the better."

Evidently Dr. Temple is moved by the oppression which schools suffer from science, and he desires to emancipate them. But to any one familiar with the facts as to scientific instruction in this and other countries, and the beneficial results which proceed from it, Dr. Temple's strongly-expressed desire will appear astounding. The schools in which science is successfully taught (and we count success not so much by examinational results as by the training of the mind and eye and hand, and the development of the spirit of inquiry), invariably contain the most intelligent scholars; the towns or districts which possess properly organised and equipped science schools contain

the largest proportion of skilled and inventive workmen. It is in the elementary schools that the foundations of natural knowledge should be laid, and there the faculty of observation should be trained to feed the mind; yet these are the schools which the Bishop of London would shut out from the light of science. For many years men interested in scientific education have been striving for a fuller recognition of science in our educational system, and not without a certain measure of success. But now comes Dr. Temple and says in spirit, if not in the exact words, "Away with all these abominations. Purge the elementary schools of everything scientific, and substitute dogmas and subjects more fitted to the stations of life in which it has pleased God to call the scholars." It is difficult to believe that sentiments so antagonistic to scientific study should have been uttered towards the end of the nineteenth century, and by one who is regarded as a friend of educational progress. But it is gratifying to know that Dr. Temple is only expressing the desire of a few ecclesiastics when he declares for the expulsion of science from elementary education. All who have the good of the country at heart, and who know the immense industrial harvest which Germany has reaped, and is reaping, as the result of generous provision for science in education, will regret that a man in the exalted position of the Bishop of London should have been the mouth-piece of words so narrow in their signification as those we have quoted—words which really lead one to think that he has not yet grasped the difference between "education" and "instruction." As it happens, we have received during the past week a copy of the address delivered by the Right Hon. A. J. Mundella to the members of the Association of Technical Institutions at their last annual general meeting, and we subjoin a few extracts from it, in the hope that they will lead Dr. Temple and his friends to a better appreciation of the value of scientific education.

Germany and Switzerland have, for more than half a century, been perfecting their educational system. They have trained up two generations in the most efficient and best manner that these two nations can afford, and they have profited very largely by it.

Now, to my mind, it is astonishing that this should be the case with such comparatively poor nations, because they have made their institutions accessible to every citizen, even to the poorest. There has been a lavishness amounting almost to extravagance in their expenditure. A few years ago I was in Berlin, and I was talking to my old friend Prof. Hofmann, who was then at the head of that great Charlottenburg Institution, the first technical institution in Europe. I remarked to him that I had been through various institutions in Germany and Switzerland the previous year, and it seemed to me that they were rather over-producing scientific men, the supply was in excess of the demand. "It is true," he said, "that we are producing more than we can absorb. We have a plethora of scientific men; only this year in my own department, two hundred Doctors of Science have taken degrees in the universities of Germany. But you must bear one thing in mind; *we have the export trade entirely to ourselves*."

"Go where you will throughout the world, you will find the German chemist at the head of every industry into which chemical science enters. I was in America, making a journey through the States some two or three years ago, and wherever I went I was entertained by German chemists and German scientific men, many of whom were old students of mine. They were at the head of every industry to which scientific knowledge is applicable, chemical works, gas works, breweries, whatever it was a German was at the head of it." And he said, "You know that pays. When a German scientific man wants plant or machinery, and that plant is manufactured in Germany, he goes to Germany for it, he does not go to England." That is quite true. The position that the German chemist, the German scientist, the German technologist has taken throughout the world, has done much to assist German industry.

The extent to which Germany and Switzerland have profited by technical teaching, is hardly realised by the English people. We are beginning to learn it; Switzerland, we are told by Sir O. Adams, in his excellent book on the "Swiss Confederation," exports a greater amount of manufactures per head for her population, than any other country in the world. It seems almost incredible that it should be so, that a country without natural resources, without iron, without coal, without a port or a navigable river, should nevertheless have a greater export of manufactures than any other nation in the world, not excepting England. But it is *true*, gentlemen, and she owes it entirely to her *education*. . . .

Look at Germany. What has Germany gained by her sacrifices? I have been reading the most recent consular reports from that country: they furnish a mass of testimony in proof of the advantages she is reaping from her persistency in an enlightened educational policy. Hamburg trades very largely with English-speaking countries. Years ago she made English a compulsory subject in her common schools. She has been unsparing in expenditure for the equipment of her citizens, and she is reaping her reward. If, thirty years ago, any one had ventured to prophesy that in 1895 the tonnage of sea-going ships touching at Hamburg would exceed that of Liverpool, we should have laughed him to scorn; but this "striking fact" was announced to us a few days ago. Our Consul at Stettin reports that the educational authorities of that city propose to devote four hours a week to the study of English in the common schools. What would be said in England if a School Board on the north-east coast was to make German a compulsory subject?

After stating a number of remarkable instances of the effects that foreign competition is having upon British trade and employment, Mr. Mundella continued:—

Let us ask ourselves why it is that our rivals are so successful? In the first place their elementary schools are thoroughly efficient. The teaching staff consists of trained adults, 90 per cent. of them being men. The scholars attend with astonishing regularity, and the school-life is sufficiently long to permit of their mastering the full curriculum of the school. When at the age of fourteen (in Switzerland it is often fifteen) the continuation school perfects, and adds to, the knowledge acquired in the elementary school. Then follows the high school, the technical school, and the university. There is no waste of effort; no overlapping; everything is co-ordinated; and everything is accessible to "the youth of pregnant parts." Fees are sufficiently low, or scholarships are provided, to admit of the humblest scholar of promise securing a thoroughly sound education. In Switzerland the high schools are free as well as the elementary, and the fees at the Polytechnicum at Zürich do not exceed £4 per annum. . . .

Well, gentlemen, what is our position? We are still the first industrial nation in the world. What is our educational position? Are we first? Comparisons are odious. They are in this case; one hardly likes to make them.[1] Having regard to our wealth, the magnitude of our industries and of our commerce, the vast interests that we have in our keeping, we ought to be the first. Why are we behind, and what ought we to do to obtain supremacy in education as well as maintain it in industry? Well, you must begin at the bottom, you must improve the elementary education. We, to a great extent, owe the present condition of things to the early leaving of school, to the half-time system, to the low standards which prevail, especially in the country districts, where the fourth standard is the standard of total exemption. Think of the numbers that enter factories at eleven years of age. Think how few stay at school until they are thirteen or fourteen. It is true we have done excellent work under Forster's Act. We should take shame to ourselves that we have not done more. but we have done as much as the country would allow us; and we have been always, I think, in advance of the opinion of the country.

We trust that these extracts from Mr. Mundella's address will bring the Bishop of London to a better understanding of the place and value of science in education.

[1] Dr. Virchow visited England four or five years ago, and on his return to Berlin he reported, "England is a century before us in sanitation, and a century behind us in education."

NOTES.

A PHOTOGRAVURE of Sir Joseph Lister, President of the Royal Society, accompanied by a biographical sketch, will appear in next week's NATURE, as an addition to the series of "Scientific Worthies."

THE "James Forrest" lecture of the Institution of Civil Engineers will be delivered on Thursday, May 7, by Dr. A. B. W. Kennedy, F.R.S., the subject being "Physical Experiment in relation to Engineering."

PROF. EHRLICH has been appointed Director of the new State Institute in Berlin for the testing of therapeutic serum.

THE Trustees of the late Earl of Moray have granted a donation of £1875 to the Ben Nevis Observatory.

THE Bill before the House of Representatives adopting the metric system of weights and measures as legal standards in the United States, has (says *Science*) been referred back to the Committee. The Bill was ordered to a third reading by a vote of 119 to 116, but this vote was afterwards reconsidered.

DR. J. E. AITCHESON, C.I.E., the naturalist who was attached to the Afghan Delimitation Commission, has returned to London from North-West India and Kashmir, where for the past four years he has been continuing the further investigation of the fauna and flora of those regions.

WE regret to announce that Prof. Dr. Adalbert Krueger, Director of the Kiel Observatory, died on Tuesday, April 21. He was in his sixty-fourth year.

THE deaths are announced of M. Joaquim P. N. da Silva, distinguished for his archæological works, at Lisbon, in his ninetieth year; M. Jules Lefort, Member of the Paris Academy of Medicine, and the author of many treatises on pure and applied chemistry and pharmacy, his most important work being in connection with water analysis; Prof. Dr. Ofterdinger, at one time Professor of Mathematics and Astronomy in Tübingen University; and M. J. B. Dureau, the founder, in 1860, of the *Journal des fabricants de sucre*. M. Dureau was also the author of a "Rapport sur l'Industrie de sucre à l'Exposition universelle de 1867," and of a valuable work entitled "l'Industrie du sucre depuis 1860."

WE learn from *Terrestrial Magnetism* that M. Moureaux has been entrusted by the Minister of Public Instruction, at the request of the Imperial Russian Geographical Society, with the investigation of a pronounced anomaly in the distribution of terrestrial magnetism, which certain observations have revealed in Southern Russia.

ARRANGEMENTS are being made in Limoges to celebrate this year the centenary of the introduction of porcelain into France, by means of an Exposition, in which the history of porcelain manufacture will be traced by specimens of work and processes. The Exposition is being organised by the Société Gay-Lussac, working in conjunction with representatives of the town of Limoges.

ON Tuesday next, May 5, Mr. C. V. Boys, F.R.S., will begin a course of lectures at the Royal Institution, on "Ripples in Air and on Water"; and on Thursday, May 7, Mr. W. Gowland, late of the Imperial Japanese Mint, will begin a course of lectures on "The Art of Working Metals in Japan." The Friday evening discourse on May 8 will be delivered by Prof. Silvanus P. Thompson, F.R.S., his subject being "Electric Shadows and Luminescence." That on May 15 will be on "Cable Laying on the Amazon River," Mr. Alexander Siemens being the lecturer.

WE learn from *Science* that Mr. William I. Hornaday, formerly of the U.S. National Museum, has been appointed Director of the proposed Zoological Park in New York. He enters upon his duties immediately, and will first consider and report to the Executive Committee upon the difficult question of location of the Park. At the last meeting of the Society the three first honorary members were elected as follows: Sir William H. Flower, Prof. Alexander Agassiz, and Prof. J. A. Allen.

OUR American correspondent writes under date April 17:—"Prof. Frederick A. Starr, of the University of Chicago, has just returned from a three months' tour in Central America. He found many genuine dwarfs, but not constituting a tribe, as they spoke nineteen languages in Oaxaca, thirteen in Chiapas, and twenty-one in Guatemala, indicating a lack of unity among them.

"The new remedy for consumption, aseptolin, the formula for which has recently been given to the world by Dr. Cyrus Edson, is now used in the New York State's prisons at Sing Sing, Dannemora, and Auburn, with marked success. At the last-named prison there was not one death from consumption during the entire month of March, which is quite unprecedented. Twenty thousand cases are under treatment, the larger number being outside the prisons, with two hundred cures reported.

"It is remarkable that with the abundant sea-life teeming about it, and within short distances, New York City has never possessed an aquarium. Castle Garden has now been converted to that use, and will be opened to the public within a few weeks with admirable equipment. It is peculiarly fortunate that the underlying strata are such as to filter the water from the adjoining harbour, thus providing an inexhaustible supply of pure sea-water for the tanks from an artesian well.

"The extraordinary weather, perhaps, deserves another note. While snow-storms still prevail at the West, and three feet of snow, being the heaviest snow-fall in many years, was reported on Monday from New Mexico, unprecedented heat has prevailed along the North Atlantic seaboard for five days, the thermometer reaching 85° at New York City on the 16th, and again to-day, which exceeded by 14° all previous records of same date, and was hotter than any April weather previously recorded. From other points still higher temperatures were reported: 90° at Hartford, Conn., and Moonsocket, R.I.; 92° at Manchester, N.H., and 94° at Middletown, N.Y."

THE summer meetings of the Institution of Naval Architects will be held this year in Hamburg, on Monday, June 8, and the following day. On Wednesday, June 10, the meetings will be transferred to Berlin, on the invitation of the Imperial German Government, and they will be continued there during the remainder of the week. Full particulars of the papers to be read, of the works and places of interest to be visited, and of the excursions and entertainments which are being organised, will shortly be issued. The meetings are receiving the warmest support from the Imperial Government, under whose direction the arrangements in Berlin are being prepared.

ON July 2 the Second International Congress of Applied Chemistry will open in Paris. In addition to strictly technical questions, the congress will discuss the analytical processes needed for the guidance of manufacturers and the benefit of the consumer. The proceedings will be conducted in ten sections, and, judging from the number and interest of the questions which will be brought up in each, there will be no lack of work. The sections represent such diverse subjects as chemical products, electro-chemistry, colouring matters and dyeing, pharmaceutical products, metallurgy and mining, sugar-refining, vintnery, brewing, distilling, agricultural chemistry, photography, alimentation, and milk-supply. The Association des Chemistes de Sucerie et de Distillerie, which is organising the congress, has formed a

Committee, comprising several members of the French Government, a large number of members of the Institute, and many of the foremost men in science and industry in France. Further information with reference to the congress can be obtained from M. Dupont, 156 boulevard Magenta, Paris.

THE Marine Biological Laboratory at Plymouth has been the scene of more than usual activity during the past month. In addition to the permanent staff of the laboratory, five botanists and zoologists have been engaged in biological research, and the students' laboratory, recently equipped for the accommodation of vacation parties, has had its resources taxed to the uttermost. Fifteen students in all—six from Cambridge, five from Oxford, three from the Owens College, Manchester, and one from University College, London—have formed Mr. Garstang's vacation class, and have made full use of the liberal provision made for them by the Director of the laboratory and his staff. The arrangements for the class have consisted of daily expeditions for trawling, dredging, tow-netting, and shore-collecting purposes to various parts of the neighbourhood, and of daily lectures and demonstrations on the results of the expeditions, and on general topics connected with marine biology. Especial attention has been paid to the life-histories of animals—to their bionomical relations and to problems of use and function—so as to comprise a body of instruction supplementary to the morphological studies of university laboratories. The class has admittedly been a great success, and the students have returned to their various universities not only with a store of new facts, but with renewed interest in biological pursuits. A similar class will be formed for August next. The *Busy Bee*, the new steamboat of the Association, has satisfactorily fulfilled all the tests imposed upon her, and proves to be eminently suitable for the routine work of the laboratory. Among the more interesting of recent captures may be mentioned the discovery of several examples of a species of the Amphineuran *Proneomenia*.

THE annual general meeting of the British Ornithologists' Union was held at 3 Hanover Square, on the 22nd inst. In the absence of Lord Lilford, the President, Mr. P. L. Sclater, F.R.S., took the chair. The report of the Committee stated that *The Ibis* (the journal of the Society) had been regularly published during the preceding year, and that the Union consisted of 269 ordinary members, besides honorary and foreign members. Twenty-nine new ordinary members and one new foreign member, were proposed and elected. Mr. Sclater brought forward a scheme for a new synopsis of the described species of birds, to be arranged in six volumes, corresponding with the six zoological regions of the earth's surface. This was referred to a Committee to report upon.

WE have received a copy of the draft programme of questions proposed for discussion at the International Meteorological Conference to be held in Paris in September next. Numerous questions in general meteorology, terrestrial electricity and magnetism, and international meteorology are down for discussion. Among these questions and propositions we notice that Dr. P. Schreiber (Chemnitz) will propose that the meteorological day shall be reckoned from 9 p.m. to 9 p.m., and designated by the same number as the civil day, while meteorological extremes and sums, *e.g.* of rain fallen, shall be measured at 9 p.m. Prof. Willis L. Moore (Washington) will put forward the solar magnetic period 26·67928 days as the natural mode of classifying solar, physical, and terrestrial meteorological phenomena, and suggest the desirability of its introduction for general use in the year 1901. The Royal Meteorological Society suggests (1) the desirability of more extended observations on infiltration into the soil, and uniformity in the same; (2) the general adoption of a standard anemometer for the determination of the velocity of the wind; (3) the general adoption of a uniform system of exposure for anemometers; (4) uniformity of conditions under which earth temperatures should be taken. Prof. H. Mohn (Christiania) will introduce the question of determining the pressure of the air by means of the observation of the boiling point of water (the hypsometer) with the accuracy necessary for meteorological purposes; and also that of the determination of the gravity correction for mercurial barometers by simultaneous observations of the hypsometer and the mercurial barometer. Dr. Billwiller (Zürich) will urge the necessity for the introduction of a uniform method of reduction of barometer readings to the sea-level for the construction of synoptic weather charts. Rev. Father Faura, S.J. (Manilla), will suggest that the time has arrived to settle the question of air motion in cyclones, and to finally disprove the theory of descending currents in these phenomena. Prof. E. Mascart (Paris) will treat of atmospheric electricity and terrestrial magnetism. Prof. von Bezold (Berlin), and Prof. Eschenhagen (Potsdam) will propose that certain general principles should be introduced for the publication of magnetic observations, and should be laid down for magnetic surveys. They will also suggest that it is desirable that all institutes which publish magnetic charts should give additional tables containing the magnetic elements, and, if possible, also the components for convenient points of intersection of the geographical co-ordinates. Other questions which they suggest for discussion are the distribution of magnetic observatories, and simultaneous international observations.

THE last published Report of the Central Physical Observatory of St. Petersburg gives particulars of the working of the vast and important meteorological service in Russia, and is the last summary which will be prepared under the efficient superintendence of Prof. H. Wild, who has now retired from the directorship. The number of stations returning regular observations amounted to 642, of which 438 were in Europe, and the remainder in extra-European localities. Before publishing these observations, they have been subjected to careful revision, *inter se*, and to comparison with synoptic weather charts. Storm-warning telegrams have been regularly issued to the Baltic and Black Seas, as well as to some inland seas, for which a success of 72 to 78 per cent. is claimed. Special attention is also paid to daily weather forecasts; the results are published for each separate element and for each month, the aggregate success being over 74 per cent. Special forecasts of wind and snow-storms are also issued to the railway companies. The report contains a long list of scientific investigations published under the auspices of the St. Petersburg Academy of Science.

WATER-CRESS is eaten by Caddis-worms, Caddis-worms by trout, and trout by Herons. The result of disturbing this balance of nature in a particular case is described by Miss E. A. Ormerod in the Cirencester *Agricultural Students' Gazette*. Three-quarters of a large crop of water-cresses were found to have been injured by the attacks of the water-grubs which are so well known as Caddis-worms. Isaac Walton gives evidence of the love of trout for Caddis-flies as baits, and this points strongly to their knowledge of the goodness of the larvæ for food in more natural circumstances. But in the case which Miss Ormerod investigated, the trout had been eaten by Herons, and by their removal the water-cress grower appears to have lost very helpful friends. The sequence of events consequent on local encouragement (beyond what is known as a natural balance) of one large species of birds of special habits, downwards, through destruction of insect-eating fishes, and overplus of vegetable-eating insects, to the great pecuniary loss of the grower of water-cress, deserves a place with Darwin's story of the relation between cats and clover.

DR. GREGG WILSON describes several peculiar cases of hereditary polydactylism, showing considerable variation in the position of the abnormality, in the *Journal of Anatomy and Physiology*. In one family, extra fingers or toes were so common that they were almost expected to appear upon some of the children. This abnormality persisted through six generations, and two interesting features connected with it are that it increased in the first four generations, and changed in position from the post-axial to the pre-axial side of the limb. In another case there was an increase of the abnormality, and also a change in the position from the post-axial to the pre-axial side of the limb. In a third case there was remarkable variability in the abnormality, a man with extra minimi on both feet having one son with extra great toes, and another son with extra minimi on the hands and a double middle toe on one foot. The instances studied by Dr. Wilson illustrate the variability of digital abnormalities, and in this regard they differ from the majority of cases of hereditary polydactylism, where the abnormality is very constant in position through several generations, though not in degree. In a few cases the abnormality has been found to pass in successive generations from the outer side of the hand to the outer side of the foot, and *vice versa*, but it is rare that it passes from one side of a limb to the other, as in the five cases sketched by Dr. Wilson.

ON April 13 a meteorite, weighing two kilogrammes, fell at Lesves, near Namur, Belgium. In its fall it very nearly killed a young man who was working in an orchard, and it embedded itself into the earth to a depth of 50 centimetres. The Abbé Renard, who examined the specimen, considers it to be a stony meteorite of chondritic structure. It consists of a whitish crystalline paste, from which are detached meteoric iron, troïlite, olivine, bronzite, and chondroi. An examination of the structure and the chemical composition of this aerolite is now being made in the laboratory of the University of Gand.

THE publication of Herr Gätke's theory of the moult in birds, in his work on Heligoland, seems to have induced other ornithologists, both in Europe and America, to turn their attention to this difficult subject. Mr. Witmer Stone has put forward his views "on the moulting of birds," in a communication made to the Academy of Natural Sciences of Philadelphia in January last. He has come to the conclusion that the annual moult at the close of the breeding season is a physiological necessity, and is common to all birds; whereas the spring moult and striking changes of plumage effected by abrasion are not physiological necessities, but depend in extent upon the height of development of colouration in the adult plumage, and do not necessarily bear any relation to the systematic position of the species. Mr. Stone scouts the idea of Gätke (adopted by Dr. Bowdler Sharpe) that feathers can actually change their colour without moult, unless it be by abrasion or bleaching. Mr. Stone gives us a large number of useful notes on the smaller land-birds of Eastern North America, based on his own observations.

A PAPER in the current number of the *Annales de Chimie et de Physique* gives the results of some recent determinations of the specific heat of boron, made by MM. Moissan and Gautier. Amorphous boron was used, and the specific heat measured by means of Bunsen's ice calorimeter. The boron was heated to three temperatures: 100°, 180°, and 230° C. The values for the atomic heat obtained at 50°, 146°, and 213° are 3·374, 4·153, and 4·766. By interpolation it is found that at a temperature of about 400° C. the atomic heat of boron would be 6·4, but the authors have made no attempts to make measurements at temperatures over 230°.

SINCE it has been shown that the velocity of propagation of an electro-magnetic disturbance in a dielectric is the same as that in a wire surrounded by the dielectric, the measurement of the velocity of such a disturbance in a wire is of great interest. M. Blondlot, who has already published the results of some experiments made on this subject, contributes an interesting paper to the current number of the *Annales de Chemie et de Physique*, giving the results of some recent experiments on the velocity of propagation of an electro-magnetic disturbance along a wire. The author employs the discharge between the outer coatings of two small Leyden jars (the "impulsive discharge" of Lodge), which occurs when a spark passes between the knobs connected to the inner coatings. Each of the jars has two outer coatings, one of which is connected to a small spark-gap by a short wire, while the other is connected to the same spark-gap by a wire about 1000 metres long. Hence on a spark passing between the knobs connected to the inside coatings, two sparks occur in the spark-gap, one produced by an electro-magnetic disturbance which has only traversed a few centimetres of wire, while the other, having started at the same time as the first, has passed along about 1000 metres of wire. An image of the sparks is thrown on to a photographic plate by a mirror rotating at a known speed. The speed of the mirror was determined by comparing, by means of a monochord, the pitch of the note produced by the vibrations of the axle in the bearings with the pitch of a tuning-fork. The "line" consisted of copper wires 3 millimetres in diameter, suspended on posts about 3 metres above the surface of the earth. The distance between each of the outgoing wires and the corresponding return, which was in the same vertical plane, was 80 cm., while the two circuits were at a distance of 40 cm. from each other. The mean of five sets of measurements gave 296,400 kilometres per second as the velocity of the disturbance, while three others in which the distance traversed was nearly twice as great, *i.e.* 1821 metres, gave 298,000 kilometres per second. The author considers that each individual measurement is probably correct to within 1 part in 100.

THE *Annals* of the Astronomical Observatory of Harvard College, vol. xl. part iv., contain an important appendix by Mr. S. P. Fergusson, upon anemometer comparisons made at Mr. Rotch's Observatory at Blue Hill, Massachusetts, in the years 1892–94. The object of the investigation was to determine the mean differences between anemometers used as standards in different countries, and to compare the results of recent whirling-machine experiments. The observatory in question is admirably adapted for the purpose, being situated upon an isolated hill, and is equipped with the best patterns of anemometers, in addition to which some instruments were supplied from other places for comparison. The anemometers, and method of comparison are fully described; very useful results were obtained, to which, however, we can only briefly allude here. The experiments show conclusively that the smaller anemometers are the most sensitive to sudden variations in velocity, the ratio of sensitiveness being nearly proportional to the size, in instruments of the same type. The fan anemometers are much more sensitive than the cup anemometers, and are therefore the most efficient for recording gusty winds; the Robinson pattern instruments, mostly used in this country, are least efficient in this sense, but they possess undoubted advantages for recording mean velocities. Dines' pressure tube anemometer was found to be an excellent instrument, especially for indicating maximum velocities. The comparisons clearly show the need of some standard form of anemometer, to which all observations heretofore made can be reduced.

THE results of much patient observation are recorded in *Bulletins* 129 and 130 of the Michigan Agricultural Experiment Station, which relate to fruit culture. Numerous varieties of fruits, embracing 156 of strawberries, 53 of raspberries, 30 of

blackberries, 44 of currants and gooseberries, 63 of cherries, 191 of peaches, 72 of plums, 37 of pears, 101 of apples, besides quinces, apricots, nectarines, mulberries, and others, were separately grown. Cultural notes were periodically written, whilst quality, vigour, and productiveness were numerically estimated according to a fixed scale. In every case, the weight of an average specimen of the fruit is tabulated, the information thus conveyed being regarded as preferable to a record of the size, and at the same time more easily and accurately acquired. The difficulties of nomenclature and synonymy are somewhat lessened by a strict following of the rules of pomology, as formulated by the American Pomological Society and the National Division of Pomology, and every effort is made to avoid ambiguity. Notes on insects and other pests—such, for example, as the currant eelworm, *Nematus ventricosus*—are added wherever necessary, and the useful effects of sulphate of copper sprayed as an insecticide are referred to. The *Bulletin* should be of great practical value to the cultivators of Michigan, a State the climate of which especially fits it for profitable fruit-growing.

Mr. David Flanery, of Memphis, Tenn., U.S.A., writes that on January 14 last, "while looking for certain stars in the east at 5.45 a.m., suddenly a great light shone behind and to the left of me, and after studying a moment to determine whether it was a flash from the trolley, or some other common occurrence, I turned around to the west, and looking up beheld a body of grey nebulous matter, such apparently as the Milky Way is made up of, slowly disappearing from view. It lasted a full minute, and without moving in any direction faded away. I heard no noise as of an explosion, but the light and the apparent smoke which had the form J plainly indicated that an immense meteor had fallen or had been consumed. The locality of the phenomenon was on the borders of the Great Bear, Ursa Major, and the Little Lion, Leo Minor, and around the two bright stars Lambda and Mu, which mark the hind feet of the Bear."

The phenomenal Eichener Lake in the Grand Duchy of Baden, which has the peculiarity of appearing and disappearing at uncertain periods, has recently again made its appearance after a lapse of time.

It will be fifty years next October since the first application of ether in surgical operations took place; and in honour of this scientific jubilee, Prof. C. Binz, of Bonn, has recently published in Richard Fleischer's *Deutsche Revue* a valuable historical sketch of the successive stages through which that beneficial discovery has gone in various countries.

Messrs. William Wesley and Son have just issued a valuable catalogue (No. 125) of works on zoology. Scientific men and institutions on the look-out for standard zoological books and papers will find the catalogue well worth consultation.

The Report of the Berlin branch of the German Meteorological Society for the current year contains, as usual, an interesting investigation into the climate of that city, by Prof. G. Hellmann, the Vice-President. The subject this year is the publication and discussion of the daily mean temperatures, and extreme values for the last forty-eight years.

The additions to the Zoological Society's Gardens during the past week include an Egyptian Jerboa (*Dipus ægyptius*) from Algeria, presented by Mr. F. J. Pringner; a Polecat (*Mustela putorius*) from Worcestershire, presented by Mr. F. D. Lea Smith; an Alexandra Parrakeet (*Polytelis alexandræ*) from Australia, presented by Mr. W. Pritchard Morgan, M.P.; a Natal Python (*Python sebæ*, var. *natalensis*), five Hoary Snakes (*Coronella cana*), a Rhomb-marked Snake (*Psammophylax rhombeatus*), a Cape Bucephalus (*Bucephalus capensis*), five Puff Adders (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; a Brown Mouse Lemur (*Chirogaleus milii*) from Madagascar, three Red Kangaroos (*Macropus rufus*, ♂ ♂ ♀), four Black Wallaroos (*Macropus robustus*, 4 ♂), an Alexandra Parrakeet (*Polytelis alexandræ*) from Australia, a Hamadryad (*Ophiophagus elaps*) from India, deposited; two Common Sheldrakes (*Tadorna vulpanser*), European, purchased.

Erratum.—In Prof. J. J. Thomson's article on Röntgen rays, p. 582, col. 2, line 5, for 4×10^{-8} centimetres, read 4×10^{-6} centimetres.

OUR ASTRONOMICAL COLUMN.

The Spectrum of Mira.—During the recent maximum of Mira Ceti, Prof. Wilsing was fortunate enough to obtain eleven photographs of the spectrum (*Sitz. Akad. Wiss.*, Berlin, March 26, 1896). The photographs are evidently very similar to those obtained by Prof. Pickering some years ago, hydrogen being represented by broad bright lines. The absence of the hydrogen line H_ϵ, which falls very near a broad line of calcium, is again very striking, and the simplest explanation of this fact is to suppose that the hydrogen light at that wave-length is absorbed by calcium vapour. This necessitates the supposition that there is a cooler layer of calcium outside the incandescent hydrogen, but the high atomic weight of calcium cautions us to regard this hypothesis as merely provisional. There is no certain evidence at present as to whether the hydrogen lines appear in the spectrum except about the time of maximum, and the Potsdam instruments are not of sufficient aperture to permit such an investigation to be made.

It is stated that there are no bright lines other than those of hydrogen, although there are parts of the spectrum (especially about wave-lengths 3894, 3906, and 4350) which give the impression of bright lines. The latter appearances are regarded simply as regions in which the continuous spectrum is thrown into relief by the absence of dark lines; similar effects, but not so marked, are said to be seen in the solar spectrum.

With the exception of the bright lines of hydrogen, the spectrum of Mira shows a nearly perfect agreement with that of the sun in the region more refrangible than $H\gamma$, while on the less refrangible side of this line the spectrum is characterised by dark flutings fading towards the red.

There is probably a slight displacement of the bright lines towards the less refrangible sides of their true positions, but the photographs are on too small a scale to permit any exact determination of the velocity in the line of sight. There is no suggestion of a doubling of the hydrogen lines such as is seen in the case of β Lyræ, but the occurrence of a strong dark line alongside $H\zeta$ reminds one of the appearance of this line in β Lyræ.

The paper concludes with a table of wave-lengths, extending from λ 3772 to λ 4755.

Comet Swift, 1896.—The comet observed by Swift on April 13 is a new one, and from its position on April 16, 19, and 20, Dr. R. Schorr has derived the following elements and ephemeris for Berlin midnight:—

$$T = 1896 \text{ April } 17.51 \text{ Berlin mean time.}$$

$$\left.\begin{aligned} \omega &= 1^\circ\ 12' \\ \Omega &= 177^\circ\ 55' \\ i &= 55^\circ\ 15' \end{aligned}\right\} 1896.0$$

$$\log q = 9.7515$$

	R.A. h. m.	Decl. ° ′	Brightness.
April 30	3 1.8	+51 55	0.72
May 2	2 51.3	+55 22	0.63

The unit of brightness is that on April 16. The comet will be very near to γ Persei on May 2.

This comet is now well placed for observation, and being circumpolar can be seen practically all night. Observations made at South Kensington by Mr. Shackleton, on the 28th inst., show that it is so bright that it can be seen with an opera-glass. The comet has a well-marked nucleus and a slight tail. Spectrum observations and measures made with a small 3-prism spectroscope, collimator 6-inch, showed three bright bands, but practically no continuous spectrum. Comparison was made with a spirit flame, and the carbon bands were seen to be identical with the bright bands of the comet, the one at λ 516 being especially bright.

RECENT WORK WITH RÖNTGEN RAYS.

IN our last week's number, Prof. J. J. Thomson brought together and discussed observations of prime importance selected from the mass of material recently published on Röntgen rays. As a supplement to this, and in continuation of the general summaries which have already appeared in NATURE, we present the following notes on papers and communications received during the past few days.

Prof. Oliver Lodge has sent us the following announcement, dated April 20.

"It has been asserted that the action of X-rays on a film is a photographic one, depending on the fluorescence of the glass backing. The truth is that a film on a ferrotype plate is just about as rapid as a similar film on glass. Thick films are much better than thin. It may be further interesting to state that if the platinum disk on which the kathode rays inside the bulb are converged is connected to the kathode, it fails to act as a source; if it be insulated, it acts fairly; while if it is connected to the anode, it constitutes a vigorous source."

It will be remembered that Prof. Röntgen found that "films can receive the impression as well as ordinary dry plates" (NATURE, January 23, p. 274), but he was doubtful whether the photographic effect was secondary or not.

From a number of papers dealing with various properties of Röntgen's rays, we learn that Herren V. Novák and O. Sulc (Prague) have observed the relative opacity for X-rays of different substances, both simple and compound (*Zeitschrift für Physikalische Chemie*, xix. 3). They conclude that the absorbing powers of the chemical element depend on their atomic weight alone, and that the absorbing power of a compound depends only on the atomic weights of the elements of which it consists, and not on the complexity of its molecules. It seems probable that the *average* atomic weight of a compound affords an index of its absorbing power. In the *Jenaische Zeitschrift für Naturwissenschaft*, Dr. A. Winkelmann and Dr. R. Straubel (Jena) have investigated the refraction of Röntgen rays, and by using prisms of various metals, obtain in each case a value of about 1 : 0·0038 referred to air. They also have measured the reflection produced by a sheet of tinfoil, and the relative transparency of different kinds of glass to Röntgen radiations. All glasses made with lead are found to be comparatively opaque. The same writers have experimented on the action of fluor-spar in intensifying the actinic effects of X-rays, and have found that the best results are obtainable with a coarse powder of the fluor-spar; finer powders producing a less marked effect. This effect is due to fluorescence, the spar emitting radiations whose index of refraction is about 1·48; indicating a wave-length of 219×10^{-6}. The March number of the *Atti della Reale Accademia dei Lincei* contains two papers, one by Signor Augusto Righi, and the other a joint paper by Drs. A. Fontana and A. Umani (Rome), both of which deal with the effect of Röntgen rays in stopping the action of Crookes' radiometer. The effect is found to be purely electrostatical, and to be due to the electrification of the glass bulb containing the radiometer; when the bulb is wetted, or electrification prevented by the interposition of a conducting screen, the radiation from a Crookes' tube does not affect the radiometer in any way whatever.

Mr. A. W. Isenthal has sent us the following letter, *à propos* of Winkelmann and Straubel's paper. He says:—"It may be of interest to your readers to learn that, within the last few weeks, Prof. Dr. Winkelmann and Dr. Straubel, of Jena University, have been successful in reducing the exposure required for the production of radiograms to a few seconds only. Acting on the few directions given, I have made a few preliminary trials, the result of which is very promising. By simply backing the sensitive plate with a most inexpensive material, I have obtained fair negatives of the finger-bones in about ten seconds, using only a 3-inch spark. As the rays in this method have first to pass through the glass of the sensitive plate, there is a probability of still further reducing the necessary exposure by substituting sensitive films (on celluloid) for the ordinary photographic plate."

With reference to the use of fluorescent screens in reducing the time of exposure, we have received the following letter from Dr. H. Van Heurck, of the Botanical Gardens, Antwerp, through Dr. Wynne E. Baxter:—

"I notice in your issue of April 16, that Messrs. L. Bleekrode and J. William Gifford announce that they have been able to reduce the time of exposure in radiography by the use of a fluorescent screen. Mr. Basilewski communicated the same fact to the Paris Académie des Sciences on March 23 last. Allow me, however, to lay claim to priority in this application of fluorescent screens, as the same was announced by me in various Antwerp journals on March 8, and again on the 12th of that month, in the *Annales (Belges) de Pharmacie*, an extract from which, in pamphlet form, I send herewith. You will also find described therein a chemical substance, viz. a newly-discovered double fluoride of uranyl and ammonium, with which screens can be made, at a nominal cost, of a luminosity and of a clearness superior to that of any screen now known to exist."

The combination of a fluorescent screen with a photographic plate was one to which every worker with Röntgen rays would naturally be led. Prof. M. L. Pupin gave a description of the combination before the New York Academy of Sciences on March 2. At a meeting of the Academy on April 6, reported in *Science* of April 10, he described an arrangement of apparatus by means of which it was found possible to produce very strong photographic effects, "but not sufficiently strong for penetration through the thigh and the trunk of the human body at reasonably short exposures and at long enough distances from the tube to obtain the desirable clearness in the pictures of these massive parts. A completely successful application of Röntgen's beautiful discovery to surgery depends for the present on a successful solution of the problem just mentioned. I have obtained one satisfactory solution with the method which I first described before the Academy on March 2. It consists in placing in contact with the photographic plate a fluorescent screen, and thus transforming most of the Röntgen radiance into visible light before it reaches the sensitive film. Photographs of the hand were thus obtained at a distance of twenty-five feet from the tube with an exposure of half an hour. At the distance of four inches the hand can be photographed by an exposure of a few seconds. It was in this manner only that I succeeded in photographing on a single plate the whole chest, shoulders, and neck of my assistant, with an exposure of seventy minutes and at a distance of three feet between the plate and the tube. The collar-button and the buttons and clasps of the trousers and the vest show very strongly through the ribs and the spinal column. This result seems to prove beyond all reasonable doubt the applicability of radiography to a much larger field in surgery than was expected a few weeks ago."

A communication on the same branch of the subject has been received from Mr. A. A. C. Swinton, under date April 22. We print his letter in full.

"The chemical action of the Röntgen rays upon a photographic film may be either a direct action or may be a secondary effect, due to the fluorescence produced in the support, or in the gelatine and silver bromide of the film itself. Be this as it may, the fact that an ordinary photographic film supported on celluloid is almost completely transparent to the rays, as may easily be proved with a cryptoscope, and also the fact that it is possible to simultaneously impress many super-imposed films, show that only a very small fraction of the energy in the rays is utilised under ordinary circumstances.

"As long ago as January 30, in some remarks that I made at the close of Mr. Porter's demonstration at University College, I suggested as a means of more completely utilising the energy in the rays, and thereby shortening the necessary exposure, the use of suitable fluorescent material applied either in the form of a screen behind the photographic film, or introduced into the substance of the film itself.

"Since I first made this suggestion, I have tried numerous experiments in the direction indicated. These were at first unsuccessful owing to the screens used not having been properly prepared. Some weeks ago, however, on renewing the experiments with a screen thickly coated with potassium platino-cyanide and gum, placed behind a celluloid photographic film, I obtained conclusive evidence that by this means the necessary exposure could be greatly shortened, and that in a less degree the same result could be accomplished by the employment of a screen thickly covered with powdered fluor-spar.

"The chief objection to this method lies in the fact that it is very difficult to avoid granular results. Unless the fluorescent material be in a very fairly divided condition, its grain shows distinctly and mars the detail of the finished picture. The platino-cyanide does not work so efficiently when finely powdered as when in moderately coarse crystals, but good results can be obtained by thickly coating a thin celluloid film with an emulsion of this salt ground to fine powder in collodion, and using the screen so prepared with its celluloid surface in contact with the

sensitive surface of the photographic film. I have obtained considerably better results with a finely ground sample of tungstate of calcium, prepared for me by Messrs. Hopkin and Williams. This may be used either in loose powder or made up with gum into a paste and dried.

"With this substance it is easy to obtain sharp and fully-exposed negatives of the hand in from five to ten seconds with a moderately excited tube, with which, with ordinary arrangements, one to two minutes' exposure would be necessary.

"I have also tried some special plates prepared for me by Messrs. Marion, into the sensitive emulsion of which fluorescent substances such as powdered fluor-spar and calcium tungstate were introduced before application to the glass. Though the results so far obtained by this method are not very satisfactory owing to granularity, the presence of the fluorescent substance in the photographic film appears undoubtedly to increase its sensitiveness to the rays.

"There is a wide field for further research on the lines above indicated, both with regard to suitable fluorescent substances and the best method for their application."

A paper by Dr. Ferdinando Giazzi, of the Regio Istituto Tecnico, Perugia, is of importance in this connection, and the following translation of it, by Mr. G. H. Baillie, will be useful to chemists who are preparing fluorescent salts for use with Röntgen rays:

"Some days ago Prof. Ruata called my attention to the telegram sent by Edison to Lord Kelvin, and published in NATURE, according to which calcium tungstate, when suitably crystallised, showed fluorescent phenomena under the action of X-rays in a far more marked degree than barium platino-cyanide.

"I immediately consulted Prof. Bellucci, who informed me that calcium tungstate could be easily obtained from either sodium tungstate or tungstic acid, two commercial products selling at a low price. Having obtained these from the firm of Bonavia of Bologna, I set to work and produced some calcium tungstate, but in an amorphous form, which was, as far as I could test with the coil at my disposal, insensible to X-rays. I shall not describe all the attempts I made by wet and dry processes to obtain the salt in the desired form. I merely say that I never have dealt with a body so intractable. The following is the process I finally adopted in preparing it for surgical purposes. I treated a dilute aqueous solution of sodium tungstate with a solution of calcium chloride, given to me by my colleague Prof. Corneliani; I thoroughly washed the resulting pure white precipitate, and dried it at a gentle heat in a porcelain capsule. Next I made a small hole in a piece of fresh retort-carbon, and filled it with the precipitate, which I fused and boiled by means of a small flame from an oxyhydrogen blowpipe. After boiling for some seconds (at a bright white heat), I gradually removed the substance from the hottest parts of the flame, so that solidification took place only after a few minutes. In this way I obtained five globules of calcium tungstate of the required structure. I powdered them in an iron mortar and sifted the powder on to a gummed card, which I exposed in the camera to Röntgen rays. The result was most striking; I saw at once the shadow of the skeleton of my hand more clearly than I ever have with other preparations. A surgeon with this product, good Crookes' tubes. a large coil, and an apparatus such as I have arranged, could certainly dispense with the tedious process of photography.

"I publish this note for the assistance of those who perchance have not yet succeeded in preparing the invaluable tungstate in the desired form."

So far as the utility of the method of reducing exposure by means of fluorescent screens is concerned, the advantage gained must be understood only in a comparative sense. Some investigators obtain excellent results without the use of the screen in less time than others with a screen. Dr. John Macintyre, who has sent us several communications previously upon his work with Röntgen rays, has something to say about the reduction of exposure by screens, in a letter just received. He remarks:

"The object of this note is not to minimise the importance of any aid which the physicist may place in the hand of the surgeon. I have been aware of this new method, but my experience in practice has not encouraged me meantime to pursue it largely, because of want of time in developing what I consider of greater importance, viz. a better Crookes' tube. In surgery what we require may be divided into two parts: (1) rapid views of objects, and (2) permanent records. In practice we must have for the former not photographs but direct vision, and for the second, of course, rapid exposures. Now it may occasionally happen that a permanent record is desirable of what must be done almost instantaneously. That point I think ought to be reached ere long.

"Some weeks ago I recorded a photo of the elbow-joint in $1\frac{3}{4}$ minutes, and that at a time when we did not understand the tubes as well as now. Since then I have obtained records of metallic objects in half a second, and the bones of the hand in six seconds, without the aid of fluorescent screens. What we desire most, however, in practice is a better Crookes' tube for fluorescent screens in direct vision. At present I go while the tube is being exhausted, and test the result before it is taken off the pump. When I am examining an object with the screen, or about to photograph, I heat the tube and keep the current passing through until the maximum effect is obtained. I have now seen by this means the different bones of the extremities and joints; moreover, I have no difficulty in seeing through the body itself. The spine ribs, sternum, clavicle and scapula can be seen; and I have shown to several medical men the shadow of a coin in the gullet (impacted for six months), opposite the fourth dorsal vertebra. Foreign bodies in the extremities are, as a rule, easily seen.

"For the examination of the cavities inside the head, *e.g.* the antrum, or mouth, or pharynx, also the teeth, I now place fluorescent screens in the mouth, and the Crookes' tube outside, either above or below the level of the buccal cavity as required, and sharp images are thus obtained on the screen of not only foreign bodies, but also of the bones of the face, and roots of the teeth as well.

"Other tissues than the bones are now yielding. I have photographed the side of the neck, and shown the tongue, hyoid bone, the pharygeal cavity, cartilages of larynx and trachea of the living adult subject.

"At present we cannot afford to ignore any aid, and hence we are glad to have such hints as the fluorescent screens in photography; but it is not unlikely that all such will be more or less dispensed with as a better source of the X-rays is obtained, viz. a still better Crookes' tube."

Since the above was written, and in consideration of the question at issue, Dr. Macintyre informs us that he has made a further series of experiments on the question of rapid exposures. The tube used was one of the now well-known ordinary focus tubes, made in Glasgow. He has obtained a well-defined image of metallic objects, and distinct, though faint, image of the bones of the fingers with one flash of the Crookes' tube, produced by a single vibration of the mercury interrupter, a large coil giving an eleven-inch spark, and, of course, without using any fluorescent screen. What the extent of the time of exposure was cannot be said, but he describes it as an unknown, unmeasured, small fraction of a second. In another experiment he was able to obtain a distinct image of the bones of the forearm with sixty similar flashes of the tube.

Prof. O. N. Rood found indications of reflection of Röntgen rays from a platinum surface on March 9, and on March 13, after an exposure of ten hours, he obtained a good negative, capable of furnishing prints, of a piece of iron wire netting reflected from a sheet of ordinary platinum foil and through a plate of aluminum (*Science*, March 27). The conclusion he arrived at from inspection of the image was that "in the act of reflection from a metallic surface the Röntgen rays behave like ordinary light." Experiments made to ascertain the percentage of the rays reflected, indicated that platinum foil reflected the 1/260th part of the X-rays incident on it at an angle of 45°.

Upon the question of reflection and refraction of Röntgen radiance, Prof. Pupin pointed out in his paper read before the New York Academy of Science, on April 6, that it was discussed by Prof. Röntgen in Sections 7 and 8 of his origina essay. Neither by photography nor by the fluorescent screen could Prof. Röntgen detect an appreciable refraction with certainty. A reflection from metallic surfaces in the immediate vicinity of a photographic film was detected, "but," translating Röntgen's own words, "if we connect these facts with the observation that powders are quite as transparent as solid bodies, and that, moreover, bodies with rough surfaces are, in regard to the transmission of X-rays, as well as in the experiment just described, the same as polished bodies, one comes to the conclusion that regular reflection, as already stated, does not exist, but that the bodies behave to the X-rays as muddy media do to light." "In face of these observations," continues Prof. Pupin, "Prof. Rood's and Mr. Tesla's experiments must be interpreted as a confirmation of Prof. Röntgen's results, and not as a

demonstration of the existence of a regular reflection. Mr. Tesla infers regular reflection from his theory of bombardment. His experimental method is the same as that of Prof Rood; that is, he places a reflecting plate at an angle of forty-five degrees to the direct ray, and then places the photographic plate at right angles to the direction in which the reflected ray should pass if regular reflection existed. On account of the greater power of his apparatus, his time of exposure was one hour, whereas that of Prof. Rood was ten hours. It is evident, however, that an effect upon the photographic plate does not prove the existence of regular reflection."

In his own experiments on reflection, Prof. Pupin aimed at getting rid of the photographic plate and substituting the fluorescent screen in its place.

He concludes as follows:—"These experiments prove beyond all reasonable doubt that the Röntgen radiance is diffusely scattered through bodies, gases not excepted. We may call it diffuse reflection, if we choose, provided that we do not imply, thereby, that we must necessarily assume an internal inter-molecular regular reflection, in order to explain the phenomenon. For if a puff of smoke be forced through a pile of wood, some of it will come out pretty well scattered, although we cannot speak here of a reflection in the ordinary sense, but rather of deflection, reserving the term 'reflection' for those particular cases in which the angle of incidence is equal to the angle of deflection. It might turn out, for instance, that the X-rays are due to a circulating motion of ether, and that the stream lines are deflected and diffusely scattered within the molecular interstices of ponderable substances. Appearances seem to speak more in favour of this view than in favour of a wave motion of ether. The diffuse scattering of the Röntgen radiance by bodies placed in its path may be also described by saying that *every substance when subjected to the action of the X-rays becomes a radiator of these rays*. . . . The fact that opaque bodies, like metals, are less effective in producing this secondary radiation, leads to the conclusion that there is in these bodies an internal dissipation of the Röntgen radiance much greater than in the case of transparent dielectric substances. A properly constructed bolometer should give us much information on this point, and it is my intention to take up this subject as soon as time and facilities will permit. These diffusion effects, which are present even in air, bring the Röntgen radiance into still closer resemblance to the principal features of the kathode rays which were studied by Prof. Lenard. The difference in their behaviour towards magnetic force is still to be explained. Is it not possible that this magnetic effect in air is masked by the diffuse scattering of the X-rays?"

Our American correspondent says:—"Tesla has found that the X-rays are reflected from certain metals tested in the same order as in Volta's electric contact series in air. Zinc reflects 3 per cent. at an angle of 45°. Below it stand lead and tin, but his observations do not yet show which reflects more highly. Below these in order come copper and iron about the same, then silver. His first observations led him to infer that magnesium would reflect still more than zinc, and sodium most of all. Subsequent experiment has verified the conjecture as to magnesium; but sodium has not yet been tested. By availing himself of the reflection from a zinc cone, he has taken a picture of the ribs of an assistant at a distance of four feet from the vacuum tube, and with an exposure of forty minutes. His apparatus is so constructed that the bulb or bulbs are at the large end of the cone, and the subject at the small end, where the rays are concentrated. The cone or funnel is constructed at an angle less than 30°, so that the incident rays are reflected more than 3 per cent; and especially more the small end of the funnel the rays approach within a very few degrees of parallelism with the reflecting zinc. Prof. Tesla thinks the theory that the X-rays consist of streams of radiant matter, is confirmed by these results. He has not yet been able to detect any refraction of the X-rays."

In the summary of work done in connection with Röntgen rays (page 522), we give an account of experiments made by Prof. Joly, which demonstrate the existence of reflection.

"In confirmation of these experiments," writes Mr. Alfred W. Porter, "may I point out that a similar phenomenon to that described by Prof. Joly has been present on all my skeletal radiographs. Immediately surrounding the sharp geometric shadow of the flesh of the fingers a black line exists on the *negative*. This is especially noticeable where two fingers overlap one another; the partial shadow cast by one finger preventing the deposit on the plate from becoming so dense as to obscure h presence of the black line. I enclose a *positive* which shows the presence of the corresponding white line very clearly. My attention was first called to the presence of this line on my pictures on January 28, by Mr. John T. Morris, of this College. I believe that the prominence of the finger-nails is due to the same cause. I have also taken graphs of over-lapping wood, metal, and ivory objects which exhibit the same phenomena."

We have received the prints referred to by Mr. Porter, and they entirely bear out his description of the appearance presented.

For some time past Prof. FitzGerald and Mr. Fred. T. Trouton, at Trinity College, Dublin, have sought evidence of crystalline action, both on transmission and reflection at grazing incidence of Röntgen rays. Though so far this has been without success, we learn that they have noticed a marked scattering of the rays in transmission through some substances. The following arrangement is convenient for showing this. "On a plate of lead, which has a slit cut in it, is placed a sheet of, say, solid paraffin 2 or 3 m.m. thick, so as to cover one end of the slit; over this is laid a strip of lead—but slightly wider than the slit—so as to just entirely cover the slit. No direct radiation then can pass from a Crookes' tube, placed vertically over the slit, to a sensitive plate placed behind the lead; but with a lengthened exposure (20 to 30 minutes) with a focus tube, a darkening is found on developing at the end where the paraffin is placed. If the paraffin be then moved to the centre or other end, so as to eliminate accidental effects, on again exposing the darkening action is found to follow the paraffin. Some darkening always occurs even where there is no solid body. How much of this is due to successive reflections from the lead sheet and strip, or how much is due to scattering of the rays by air, is not easy to say."

Mr. Dayton C. Miller has obtained some good results at Case School of Applied Science in Cleveland, Ohio, U.S.A., but the exposures he finds necessary are longer than those given by the foremost workers in Great Britain. The tube used by him is spherical in shape, and about five inches in diameter. The coil gives a six-inch spark in air, and is excited by a current of about sixty watts, obtained from fifteen cells of storage battery. The voltage used varies from twelve to twenty. With this apparatus and power, Mr. Miller says:—

"The bones of the fingers are distinctly shown with exposures of ten seconds, while exposures varying from two to ten minutes are regularly used in locating bullets and shot in the hand, and in examining injured or deformed hands. An excellent picture of a hand and fore-arm, placed diagonally across an 11 × 14 plate, has been made with twenty minutes' exposure. The entire detail of the lettering and design of an aluminium medal has been taken in five minutes. Numerous interesting surgical cases of fractured and diseased arm-bones have been examined with satisfactory results. Photographs of the chest and head have been made with exposures of one hour in each case. A surprising amount of detail is visible. The chest picture shows the shoulder-joint, the collar-bone, the spinal column with its articulations, and a dark streak along its length corresponding to the spinal cord, and eight ribs on each side of the spine. In the region of the heart the detail is less conspicuous, indicating that the heart is more opaque than the lung tissue."

Mr. W. L. Goodwin, of the School of Mining, Kingston, Canada, has sent us the results of experiments made to determine the relative opacities of various substances to Röntgen rays. The only details as to the method employed is that the results were obtained "by photography with a small Crookes' tube similar in shape to a radiometer, but constructed to show the revolution of a platinum vane covered on one side with mica." The relative opacities thus determined are as follows:—

I. Solids:—

Transparent: Paraffin wax, wood charcoal, coke (in part), asphalte, albertite, starch, diamonds.

Fairly transparent: Citric acid, jet, anthracite, amber, natrolite, caustic potash, caustic soda, borax, soda crystals.

Somewhat transparent: Silicified wood, Epsom salts, serpentine, staurolite, stilbite, lazulite, $H_2(NH_4)PO_4$, cryolite, Mohr's salt, analcite, Na_2CO_3, borax glass, nitre, Rochelle salt.

Somewhat opaque: Mica, tourmaline, wulfenite, axinite, spinel, calcite, aragonite, kaolin, $NiSO_4(NH_4)_2SO_4.6H_2O$, $NiSO_4.K_2SO_4.6H_2O$, &c.

Opaque: Roll sulphur, crystal of rhombic sulphur, fluor-spar, topaz, beryl, ruby, quartz, NaCl, chalco-pyrite, $H_2(NH_4)AsO_4$, H_2KAsO_4, K_3FeCy_6, $K_2Cr_2O_7$, orpiment, anhydrite, celestine, barite.

Sulphuric acid is as opaque as the same thickness of sulphur. Water is more opaque than paraffin wax.

A number of crystals of about the same thickness were photographed on the same plate, and an attempt made to judge of their relative transparency with a scale from 1 to 10, with the following results:—

H_2KAsO_4	1
$H_2(NH_4)AsO_4$...	2
$NiSO_4.(NH_4)_2SO_4.6H_2O$	3
$MgSO_4.K_2SO_4.6H_2O$...	3
$NiSO_4.K_2SO_4.6H_2O$	3·5
$MgSO_4.(NH_4)_2SO_4.6H_2O$	4
$ZnSO_4.(NH_4)_2SO_4.6H_2O$	4
$CoSO_4.K_2SO_4.6H_2O$	4
$CoSO_4.(NH_4)_2SO_46H_2O$	4
$H_2(NH_4)PO_4$	5
Paraffin wax	10

The different values of arsenic and phosphorus in the isomorphous acid arseniates and phosphates are to be remarked.

Thin sections of a granite composed principally of quartz and feldspar and of a hornblende-gabbro were photographed. In both cases the feldspar was found to be distinctly more transparent than the other constituents.

Prof. E. Doelter, of Graz, has communicated to the *Naturwissenschaftliche Verein für Steiermark* some observations relating to the opacity of different rocks and minerals for the Röntgen rays, and their use as providing a test of the genuineness of precious stones. Dr. Doelter finds that (1) the opacity does not always increase with the density, although minerals having a specific gravity greater than 5 are relatively opaque; (2) the complexity of the chemical constitution of a mineral affects its opacity, but no general law of relationship can be enunciated; (3) dimorphous minerals exhibit but slight differences in their behaviour with regard to the rays in their different forms; (4) in most crystals, the amount of absorption does not depend sensibly on the direction of the incident rays; (5) all minerals naturally fall into about eight well-defined groups, according to their opacity, the order being as follows: diamond, corundum, talc, quartz, rock-salt, Iceland spar, &c. The diamond is ten times as transparent as corundum, and 200 times as transparent as tinfoil.

Mr. W. Ackroyd and Mr. H. B. Knowles have systematically examined the opacity of a number of substances for Röntgen rays, with a view to determining whether it bears any relation to molecular weight (*Journal* of the Society of Dyers and Cleaners, April).

With this view they have compared the isomorphous sulphates, RSO_4, $7H_2O$ of the eighth group of metals, iron, nickel, and cobalt; the oxides, RO, of some members of the second natural group, viz. magnesium, zinc, and mercury; the isomorphous oxides, R_2O_3, of the metals aluminium, chromium, and iron. In each of these series there are presumably similarly shaped molecules for comparison, and the disturbing factor is the difference of molecular weight. The result of an hour and a half's exposure showed that the alumina was practically transparent, the chromium sesquioxide semi-transparent, while the ferric oxide was opaque. In other words, the opacity of the substance was in some direct relation to the molecular weight. There are here marked differences with big jumps in molecular weights. The same observation applies to the oxides of magnesium, zinc, and mercury. The isomorphous sulphates of iron, nickel, and cobalt are extremely interesting, because of the nearness of the specific gravity numbers, and also of the molecular weights. The iron compound, with lower specific gravity and molecular weight, appears to be the least opaque of the three, while the nickel and cobalt compounds of nearly the same specific gravity and molecular weight have approximately the same degree of opacity. The following table correlates these facts with other properties:—

Compound.	Sp. gr.	Molecular weight.	Colour.	Behaviour to Röntgen rays.
$FeSO_4$, $7H_2O$	1·85	278	Light green	Slightly less opaque than others in this group.
$NiSO_4$, $7H_2O$	1·95	280	Deep green	About the same relative opacity.
$CoSO_4$, $7H_2O$	1·92	281	Pink	
Al_2O_3	4·00	103	White ...	Transparent.
Cr_2O_3	4·99	153	Green ...	Semi-opaque.
Fe_2O_3	5·13	160	Brown ...	Opaque.
MgO	3·42	40	White ...	Transparent.
ZnO	5·47	81	White ...	Semi-opaque.
HgO	11·13	216	Red	Opaque.

The foregoing figures, conclude the authors, demonstrate the weakness of an unqualified law of density, as the denser oxide of zinc is more transparent than the less dense ferric oxide. But they point out that, adopting the legitimate method, which they have initiated, of comparing only compounds with kinship, each of the above bodies conforms to the law of density as well as of molecular weight in relation to opacity.

Dr. A. Sella and Dr. Q. Majorana (*Rend. R. Accad. dei Lincei*) describe certain experiments on the influence of Röntgen rays on the sparks produced by the discharge of an induction coil in air. The sparking distance is found to be shortened by the Röntgen rays, this effect taking place whenever these rays fall on the positive pole. In this respect the phenomenon is the reverse of that obtained by Hertz with ultra-violet light, the effect of which is to lengthen the sparking distance whenever it falls on the negative pole. The authors found that the simultaneous actions of Röntgen rays and of ultra-violet light could be made to neutralise each other by arranging the coil to give a spark of suitable length (in their experiments about 30 mm.). When the sparking distance was less, the Hertz effect predominated; when the sparking distance exceeded 30 mm., the Röntgen rays had the greater influence.

Dr. Filippo Campanile and Dr. Emilio Stromei communicate to the *Rendiconto dell' Accademia delle Scienze fisiche e matematiche* (Naples) a note on the phosphorescence and the Röntgen rays in Crookes' and Geissler's tubes. The conclusions arrived at are as follows: (1) When in the circuit of an induction coil, containing a Crookes' tube, a spark is thrown off from the positive pole, the phosphorescence of the tube and the efficacy of the Röntgen radiations are augmented. (2) As the length of the spark increases the phosphorescence at first increases to a maximum, and then decreases. (3) If, on the other hand, the spark is thrown off from the negative pole, the phosphorescence and the Röntgen rays are thereby diminished. The same experimenters have also succeeded in obtaining Röntgen rays with an ordinary Geissler's tube. These radiations possessed all the characteristics of those which emanate from a Crookes' tube.

Signor E. Villari, writing in the same journal, considers that the phenomena of discharges in tubes seem to indicate the existence not only of kathodic but also of anodic rays. While the kathodic rays travel in straight lines and produce a negative charge wherever they strike the tube, the suggested anodic rays diffuse themselves all round the anode, and communicate a positive charge to the whole surface of the tube over which they are diffused.

The fundamental character of the new rays has led speculators to make various surmises as to a possible connection between these radiations and the phenomenon of gravitation, and two lengthy memoirs have been written on the subject by Rudolf Mewes.[1] In the second of these the author claims to have proved experimentally that gravitation is propagated through the ether with the velocity of light.

Finally, attention may profitably be called in this summary to the April number of the *Proceedings* of the Physical Society. In the admirable collection of abstracts of physical papers there published, will be found concise descriptions of the scope and results of no less than forty papers concerned with Röntgen rays.

1 "Licht- Electricitäts und X-Strahlen" (pp. 54); "Die Fortpflanzungs-Geschwindigkeit der Schwerkraftstrahlen" (pp. 93). (Berlin: M. Krayn, 1896.)

COLOUR PHOTOGRAPHY.

THE scientific event of last week was the description and demonstration of colour photography given by Prof. Lippmann before the Royal Society. On the occasion of the centenary celebrations of the Institute of France last year, Lord Kelvin invited Prof. Lippmann to give the Royal Society an account of his researches on photography in colours, and last Thursday's meeting was the result. The methods employed by Prof. Lippmann are well known among men of science, but few of the Royal Society were prepared to see such remarkable results as those obtained and exhibited by the distinguished French physicist. The honour and fine feeling which such visits bring to the Society, and the extreme interest aroused, should help to make similar occasions of more frequent occurrence. We print Prof. Lippmann's lecture below, and our only regret is that it cannot give an at all adequate conception of the striking achievement with which it deals.

The problem of colour photography is as old as photography itself. The desire of fixing the colours as well as the design of the beautiful image thrown on the screen of the camera, very naturally occurred to the earliest observers. Since the beginning of this century three distinct solutions of the problem have been realised.

The first solution, not quite a complete one, is founded on the peculiar properties of a silver compound, the violet subchloride of silver. E. Becquerel (1860) converted the surface of a daguerreotype plate into this silver compound, and by projecting on it the image of the solar spectrum, and other objects, obtained good coloured impressions. Poitevin substituted paper for the silver plate as a substratum. No other substance has been discovered that can play the part of the subchloride of silver. Moreover the image is not fixed, in the photographic sense of the word; that is, the coloured impression is retained for any length of time in the dark, but it is blotted out by the action of daylight. The reason of it is this: the Becquerel images are formed by coloured silver-compounds, which remain sensible to light; so that they are destroyed by the continued action of light, in virtue of the same action which gave them birth. Despite the numerous experiments made by Becquerel, Poitevin, Zenther, and others, no substance has been found that is capable of destroying the sensibility of the subchloride for light without at the same time destroying its colour.

The second method for colour photography is an indirect one, and may be called the three-colour method. It was invented in France by Ch. Cros, and at the same time by M. Ducos du Hauron (1869). German authorities claim the priority of the idea for Baron Bonstetten. Three separate negatives (colourless) are taken of an object through three coloured screens. From these three positives (equally colourless) are made; and, lastly, the colour is supplied to these positives by means of aniline dyes or coloured inks. Thus three coloured monochromatic positives are obtained, which by superposition give a coloured image of the model. In the ingenious process lately invented by Prof. Joly, the three negatives, and apparently the corresponding three positives, are obtained interwoven on one and the same plate. The three-coloured method can give a very good approximation to the truth, and has probably a great future before it. We may call it, nevertheless, an indirect method, since the colours are not generated by the action of light, but are later supplied by the application of aniline dyes or other pigments. Moreover, the choice of these pigments, as well as of the coloured screens through which the negatives have been obtained, is in some degree an arbitrary choice.

The third and latest method by which colour photography has been realised is the interferential method, which I published in 1891, and the results of which I beg to lay before you this evening. It gives fixed images, the colours of which are due to the direct action of the luminous rays.

For obtaining coloured photographs by this method, only two conditions are to be fulfilled. We want (1) a transparent grainless photographic film of any kind, capable of giving a colourless fixed image by the usual means; and (2) we want a metallic mirror, placed in immediate contact with the film during the time of exposition.

A mirror is easily formed by means of mercury. The photographic plate being first enclosed in a camera-slide, a quantity of mercury is allowed to flow in behind the plate from this small reservoir, which is connected with the slide by a piece of india-rubber tubing.[1] The slide is then adapted to the camera, and the action of light allowed to take place. After exposure the slide is separated from the camera, the mercury reservoir lowered so as to allow the mercury to flow back into it; the photographic plate is then taken out, developed and fixed. When dry, and examined by reflected light, it appears brilliantly coloured.

The sensitive film may be made either of chloride, iodide, or bromide of silver, contained in a substratum either of albumen, collodion, or gelatine. The corresponding developers, either acid or alkaline, have to be applied; the fixation may be cyanide or bromide of potassium. All these processes I have tried with success. For instance, the photograph of the electric spectrum now projected before your eyes, has been made on a layer of gelatino-bromide of silver, developed with amidol, and fixed with cyanide of potassium.

As you see, bright colour photographs may be obtained without changing the technique of ordinary photography; the same films, developers and fixators have to be employed; even the secondary operations of intensification and of isochromatisation are made use of with full success. The presence of the mirror behind the film during exposure makes the whole difference. From a chemical point of view nothing is changed, the result being a deposit of reduced silver left in the film, a brownish, colourless deposit. And yet the presence of a mirror during exposure causes the colourless deposit to show bright colours. Of course we want to know how this is done; we require to understand the theory of those colours.

We all know that colourless soap-water gives brilliant soap-bubbles; the iridescence of mother-of-pearl takes birth in colourless carbonate of lime; the gorgeous hues of tropical birds are simply reflected from the brownish substance which forms the feathers. Newton discovered the theory of these phenomena, and subjected them to measurement; he invented for the purpose the experiment called by the name of Newton's rings. Newton showed, as you know, that when two parallel reflecting surfaces are separated by a very short interval, and illumined by white light, they reflect only one of the coloured rays which are the constituents of white light. If, for instance, the interval between the reflecting surface is only $\frac{2}{10000}$ of a millimetre, violet rays are alone reflected, the rest being destroyed by interference; that is, the two surfaces send back two reflected rays whose vibrations interfere with one another, so as to destroy every vibration except that which constitutes violet light. If the interval between the reflecting surfaces be augmented to $\frac{3}{10000}$ of a millimetre, the destruction of vibration takes place for every vibration except that of red light, which alone remains visible in this case.

If we consider now this photograph of the spectrum, and especially the violet end of the image, we find that this is formed by a deposit of brown reduced silver. In the case of an ordinary photograph, this deposit would simply be a formless cloud of metallic particles; here the cloud has a definite, stratified form; it is divided into a number of thin, equidistant strata, parallel to the surface of the plate, and $\frac{2}{10000}$ of a millimetre apart. These act as the reflecting surfaces considered by Newton, and as they are at the proper distances for reflecting violet rays, and these alone, they do reflect violet rays.

The red extremity of the photograph is equally built up of strata which act in a like manner; only their distance intervals here amount to $\frac{3}{10000}$ of a millimetre, and that in the proper interval for reflecting red light. The intermediate parts of the spectral image are built up with intermediate values of the interval, and reflect the intermediate parts of the spectrum.

The appearance of colour is therefore due to the regular structure above described, imprinted on the photographic deposit. The next question is—How has this very fine, peculiar, and adequate structure been produced?

It is well known that a ray of light may be considered as a regular train of waves propagated through the ether, in the same way as waves on the surface of water. The distance between two following waves is constant, and termed the wave-length; each sort of radiation, each colour of the spectrum, being characterised by a particular value of the wave-length. Now, when a ray of light falls on a sensitive film, this train of waves simply rushes through the film with a velocity of about 300,000 kilometres per second; it impresses the film more or less strongly, but leaves no record of its wave-length, of its particular

[1] The glass of the photographic plate has to be turned towards the objective, the film in contact with the metallic mirror.

nature or colour, every trace of its passage being swept out of form by reason of its swift displacement. The impression therefore remains both uniform and colourless. Things change, however, as soon as we pour in mercury behind the plates, or otherwise provide for a mirror being in contact with it. The presence of the *mirror* changes the propagated waves into *standing* waves. The reflected ray is, namely, thrown back on the incident ray, and interferes with its motion, both rays having equal and opposite velocities of propagation. The result is a set of standing waves—that is, of waves surging up and down each in a fixed plane. Each wave impresses the sensitive film where it stands, thus producing one of these photographic strata above alluded to. The impression is latent, but comes out by photographic development. Of course the distance between two successive strata is the distance between two neighbouring waves; this, theory shows, is exactly half the wave-length of the impressing light. In the case of violet, for instance, the wave-length being $\frac{4}{10000}$ millimetres, half the wave-length in the above quoted distance of $\frac{2}{10000}$ millimetres; this, therefore, is at the same time the interval between two standing waves, in the case of violet light, the interval between two successive photographic strata, and at last it is the interval required to exist, according to Newton's theory, for the said strata reflecting violet rays, and making these alone apparent, when illumined by white light.

The colours reflected by the film have the same nature and origin as those reflected by soap-bubbles or Newton's rings; they owe their intensity to the great number of reflecting strata. Suppose, for instance, the photographic film to have the thickness of a sheet of paper (one-tenth of a millimetre), the fabric built in it by and for a violet ray is five hundred stories high, the total height making up one-tenth of a millimetre. Lord Rayleigh, in 1887, has proved *à priori* that such a system is specially adapted to reflect the corresponding waves of light.

How are we now to prove that the above theory is really applicable to the colour photograph you have seen? How can we demonstrate that those bright colours are due not to pigments, but to the interference, as in the case of soap-bubbles? We have several ways of proving it.

First of all, we are not bound to the use of a peculiar chemical substance, such as Becquerel's subchloride of silver; we obtain colours with a variety of chemicals. We can, for instance, dispense entirely with the use of a silver salt; a film of gelatine or coagulated albumen impregnated with bichromate of potash, then washed with pure water after exposure, gives a very brilliant image of the spectrum.

Secondly, the colours on the plate are visible only in the direction of specular reflection. The position of the source by which we illumine the photograph being given, we have to put the eye in a corresponding position, so as to catch the regularly reflected rays. In every other position we see nothing but a colourless negative. Now, as you are aware, the colours of pigments are seen in any direction. By projecting again a photograph of the spectrum, and turning it to and fro, I can show you that the colours are visible only in one direction.

Thirdly, if we change the incidence of the illuminating rays, that is, if we look at the plate first in a normal direction, then more and more slantingly, we find that the colours change with the incidence exactly as they do in the case of soap-bubbles, or of Newton's rings; they change according to the same law, and for the same reasons. The red end of the spectrum turns successively to orange, yellow, green, blue, and violet. The whole system of colours, the image of the spectrum, is seen to move down into the part impressed by the infra-red. This is what we expect to happen with interference colours, and what again we cannot obtain with pigments.

Fourthly, if while looking at the film normally, we suffer it to absorb moisture—this can be done by breathing repeatedly on its surface—we see that the colours again change, but in an order opposite to that above described. Here the blue end of the spectrum is seen to turn gradually green, yellow, orange, red, and finally infra-red, that is, invisible. The spectrum this time seems to move up into the ultra-violet part of the improved film. By suffering the water to evaporate, the whole image moves back into its proper place; this experiment may be repeated any number of times.

The same phenomenon may be obtained with Newton's apparatus, by slowly lifting the lens out of contact with the plane surface. The explanation is the same in both cases. The gelatine swells up when imbibing moisture. If we consider, for instance, the violet of the spectrum, the small intervals between the strata, corresponding to violet rays, gradually swell up to the values proper for green, and for red, and for infra-red; green, then red, then infra-red, are therefore successively reflected.

We will wet this photograph of the spectrum with water, project it on the screen, and watch the colours coming back in the order prescribed by theory.

It is necessary to use a transparent film, since an opaque one, such as is commonly in use, would hide the mirror from view; the sensitive substance must be grainless, or, at least, the grains must be much finer than the dimensions of the strata they are intended to form, and therefore wholly invisible. The preparation of transparent layers gave me at first much trouble; I despaired for years to find a proper method for making them. The method, however, is simply thus: if the sensitive substance (the silver bromide, for instance) be formed in presence of a sufficient quantity of organic matter, such as albumen, gelatine, or collodion, it does not appear as a precipitate; it remains invisible; it *is* formed, but seems to remain dissolved in the organic substratum. If, for instance, we prepare a film of albumeno-iodide in the usual way, only taking care to lessen the proportions of iodide to half per cent. of the albumen, we get a perfectly transparent plate, adapted to colour photography.

We want now to go a step further. It is very well for physicists to be contented with working on the spectrum, since that contains the elements of every compound colour; but we all desire to be able to photograph other objects than the spectrum—common objects with the most compound colours. We have again but to take theory as a guide, and that tells us that the same process is able to give us either simple or compound colours. We have then to take a transparent and correctly isochromatised film, expose it with its mercury backing, then develop and fix it in the usual way; the plate, after drying, gives a correct coloured image of the objects placed before the camera. Only one exposure, only one operation is necessary for getting an image with every colour complete.

A plausible objection was offered at first to the possibility of photographing a mixture of simple colours. The objection was this: a ray of violet gives rise to a set of strata separated by a given interval; red light produces another set of strata with another interval; if both co-exist, the strata formed by the red are sure to block out here and there the intervals left between the strata formed by the violet. Is it not to be feared that one fabric will be blurred out by the other, and the whole effect marred? The confusion would be still worse if we consider the action of white light, which contains an infinity of simple components; every interval here is sure to be blocked up.

Mathematical analysis, however, shows this objection to be unfounded; we have great complexity, but not confusion. Every compound ray, both coloured and white, is faithfully rendered. As an experimental proof of this, we will project on the screen photographs of very different objects, namely, stained-glass windows, landscapes from nature, a portrait made from life, and vases and flowers.

That the colours here observed are due to interference, and not to the presence of pigments, can be shown in the same way as with the spectrum. Here, again, we observe that the colours are visible only in the direction of specular reflection, that they change with the angle of incidence, that they change and disappear by wetting, and reappear by drying. Pigments remain equally visible and unaltered in colour under every incidence. If we attempted to touch up one of our photographs with oil or water-colours, the adulterated place would stand out on a colourless background by merely obscuring by diffused light. It is therefore impossible either to imitate or touch up a colour photograph made by the above described interferential method.

THE INFLUENCE OF ATMOSPHERIC AND OCEANIC CURRENTS UPON TERRESTRIAL LATITUDES.[1]

ALTHOUGH the following theorem should be implicitly contained in the formula for the rotation of a spheroid carrying a fluid on its surface, I have nowhere seen it explicitly stated.

Theorem.—Let an unconstrained, rigid sphere, with equal moments of inertia, be in a state of free rotation:

Let this sphere bear on its surface a sheet or sheets of continuous movable matter:

[1] Reprinted from the *Astronomical Journal*, No. 371, April 6.

Let this movable matter be kept in a state of steady motion relative to the sphere, by actions and reactions between it and the sphere, without the action of any external force :

Let P be the pole of the axis of rotation of the sphere, which will also be its momental axis :

Let Q be the momental axis of the total motions of the movable matter relative to the sphere :

Let I be the moment of inertia of the sphere, and M the total moment of momentum of all the movable matter around the axis Q :

Then shall the sphere take such a motion that the pole P, while remaining in a fixed direction in space from the centre of the sphere, shall move steadily relatively to the matter of the sphere around the pole Q, with an angular velocity M/I.

The application of this theorem to the case of the earth surrounded by its oceanic and atmospheric envelopes can now readily be seen. To obtain the value of M, we may roughly estimate the ratio of the moment of inertia of the earth to that of the ocean as 2600, and to that of the atmosphere as 1,000,000.

Observations, as discussed by Chandler, and interpreted by theory, indicate an annual change in the pole of the earth, which would be produced by a primary oscillation back and forth through a length of ten feet, or a revolution in a circle having a diameter of five feet. The former motion would, according to the theorem, be the necessary result of a general motion of the oceans on the two sides of the earth, which, at the point where the motion was a maximum, would be 2600 times as great. Approximately this motion would be represented by a continuous flow of the central parts of the Pacific ocean toward the pole of about 150 feet per day, with a correspondingly larger motion of the Atlantic in the opposite direction; followed by an opposite oscillation during the other six months. If, as may seem very likely, there cannot be so great a differential flow as this through Behring Strait, and between the American and Asiatic continents, it will be necessary to suppose a more rapid flow elsewhere, or a sufficient vortex in the currents of the Atlantic and Pacific oceans. Whether the currents in these oceans are deep enough to produce the observed effect must be left to hydrographers to decide.

Passing to the atmosphere, the excess of motion through one season over that of the other season, to and from the north direction, amounting to 4000 miles in six months, or say twenty miles per day, would also account for the observed change. In these statements respecting the required motions of the earth and atmosphere, I have presupposed a motion around an invariable momental axis. If the motions are such that their momental axis moves around the earth in the course of a year, the required differential motions between the opposite seasons would be only half as great.

In what precedes I have spoken of the earth as a sphere, and considered only differential motions. The actual earth being a spheroid, the motion of the pole already described would not be continuous. The actual effect of oceanic and atmospheric currents of a permanent character on the terrestrial spheroid would be to displace the mean pole of the earth from its pole of figure to such a point of equilibrium that the motion described in the theorem would be neutralised by an equal and opposite Eulerian motion, due to the ellipticity of the spheroid. The actual effect would be a revolution of the terrestrial pole, according to the known laws of rotation, around the central point of equilibrium thus fixed in 427 days. Just what the displacement is can be only a matter of guess-work; from the known magnitude of the ocean currents they might produce a displacement ranging from ten to twenty feet.

A brief statement of the character of the theoretical variations of the latitude, due to these causes, may not be inappropriate. Since the directions of the currents of the air and ocean go through an annual period, we should expect a corresponding period in the latitude. Since, however, the amount of the annual change varies irregularly from year to year, though remaining constant in the general mean, the amplitude of the annual term should be subject to small variations from time to time, while preserving its mean value unchanged from age to age.

On the other hand, the amplitude of the Eulerian motion being permanently increased or diminished by every meteorological change, may be expected to vary its amplitude in a slow and irregular manner from decade to decade. The Eulerian motion, having a period of 427 days, ought to be nearly circular, unless the equatorial moments of inertia of the earth differ much more than we can suppose probable. The annual motion may differ somewhat from a circle, and be somewhat less regular. There can be no strictly periodic changes in the latitude but these two, but it is quite possible that, owing to secular changes, or changes continued through several years, in the currents of the ocean and atmosphere, corresponding changes of irregular long period may be found in the latitude.

It will be seen that these conclusions are accordant with Chandler's results as regards the double period, but do not fully agree with them in other details. SIMON NEWCOMB.

THE PAST, PRESENT, AND FUTURE WATER SUPPLY OF LONDON.[1]

IN a discourse to the members of the Royal Institution on the subject of the metropolitan water supply nearly thirty years ago, I stated that out of every thousand people existing upon this planet three lived in London; and, as the population of London has, in the meantime, doubtless grown at a more rapid rate than that of the rest of the world, it will probably be no exaggeration to say that now, out of every thousand people alive on this earth, four live in London; and therefore, any matter which immediately concerns the health and comfort of this vast mass of humanity may well merit our most earnest attention. Amongst such matters, that of the supply, in sufficient quantity, of palatable and wholesome water, is certainly not the least in importance.

It is not therefore surprising that this subject has received much attention from several Royal Commissions—notably from the Royal Commission on Water Supply of 1867, presided over by the Duke of Richmond; the Royal Commission on River Pollution and Domestic Water Supply of Great Britain, presided over by the late Sir William Denison, of which I had the honour to be a member; and, lastly, that of 1892, of which Lord Balfour of Burleigh was the chairman.

The Royal Institution has, for nearly three-quarters of a century, been prominently connected with the investigation and improvement of the metropolitan water supply; no less than four of our Professors of Chemistry have been successively engaged in this work, namely Profs. Brand, Odling, Dewar, and myself, whilst three of them have been members of the Royal Commissions just mentioned. I may therefore perhaps be excused for bringing the subject under your notice again for the third time.

On the present occasion, I propose to consider the subject from three points of view, viz. the past, the present, and the future; and, for reasons which will appear hereafter, I shall divide the past from the present at, or about, the year 1883, and will not go back farther than the year 1828, when Dr. Brand, Professor of Chemistry in the Royal Institution, Mr. Telford, the celebrated engineer, and Dr. Roget, Secretary of the Royal Society, were appointed a Royal Commission to inquire into the quality and salubrity of the water supplied to the metropolis.

The Commissioners made careful examinations and analyses, and reported as follows. "We are of opinion that the present state of the supply of water to the metropolis is susceptible of, and requires, improvement; that many of the complaints respecting the quality of the water are well founded; and that it ought to be derived from other sources than those now resorted to, and guarded by such restrictions as shall at all times ensure its cleanliness and purity. (At this time the water was pumped from the Thames between London Bridge and Battersea.) To obtain an effective supply of clear water free from insects and all suspended matter, we have taken into consideration various plans of filtering the river water through beds of sand and other materials, and considering this, on many accounts, as a very important object, we are glad to find that it is perfectly possible to filter the whole supply, and this within such limits in point of expense as that no serious objection can be urged against the plan on that score, and with such rapidity as not to interfere with the regularity of the service."

Before the year 1829, therefore, the river water supplied to London was not filtered at all; but after the issue of this report the companies set themselves earnestly to work to improve the quality of the water by filtration.

[1] A discourse delivered by Dr. E. Frankland, D.C.L., LL.D., F.R.S., at the Royal Institution on February 21.

In the year 1832, and again in 1849, London was severely visited by epidemic cholera, and the agency of drinking-water in spreading the disease forced itself upon the attention of the observant portion of the medical profession. It was Dr. Snowe, however, who, in August 1849, first formally enunciated the doctrine that drinking-water polluted by choleraic matters is the chief mode by which cholera is propagated.

In every visitation of Asiatic cholera to London, the water supply was either altogether unfiltered or imperfectly filtered, besides being derived from highly polluted parts of the Thames and Lea; and the enormous loss of life, amounting in the aggregate to nearly thirty-six thousand people, can only be attributed to this cause; for it has now been satisfactorily proved that cholera is, practically, propagated by drinking-water alone; and that efficient filtration is a perfect safeguard against its propagation. Moreover, it is most satisfactory to know that, since the year 1854, no case of Asiatic cholera in London has been traced to the use of *filtered* river water. The first effect of Dr. Snowe's cardinal discovery was the removal of the intakes of the river water companies to positions beyond the reach of the tide and of the drainage of London. The second was the greater attention paid to the efficiency of filtration.

Such is the verdict in regard to cholera, and the same is true of that other water-borne disease typhoid fever. But unlike cholera, this disease is disseminated in several other ways, and its presence or absence in any locality may not, of necessity, have any connection with drinking-water; as is strikingly shown by the health statistics of Manchester, since the water supply of this city, derived as it is from mountain sources, is above all suspicion of this kind. These other causes have, during the last ten years, been much mitigated in London by various sanitary improvements; whilst, as shown in the diagram on the screen, there has been no corresponding mitigation in Manchester. There is no evidence whatever that, since the year 1869, when typhoid fever appeared for the first time as a separate disease in the Registrar General's report, it has been conveyed by the water supply of the metropolis.

Although very soon after the year 1856, all the water supplied to London was obtained from sources much less exposed to drainage pollution, it was still very carelessly filtered. Previous to the year 1868 there are no records of the efficiency, or otherwise, of the filtration of the metropolitan water supply derived from rivers; but at that time, I began to examine these waters for turbidity. In that year, out of 84 samples, 7 were very turbid, 8 turbid, and 10 slightly turbid; so that, altogether, no less than nearly 30 per cent. of the samples were those of inefficiently-filtered water. The metropolitan water supply then, up to the year 1868, may be shortly described as derived for many years from very impure sources with either no filtration at all, or with very imperfect filtration; and afterwards, when the impure sources were abandoned, the supply was still often delivered in a very inefficiently-filtered condition. But after the establishment of monthly reports, the quality of these waters gradually improved in this most important respect down to the year 1883, since which time the efficiency of filtration of all the river waters supplied to the metropolis has left little to be desired.

What is it, then, that separates the past from the present water supply of London? In the first place, there is the change of source—I mean the change of the position of the intakes of the several companies drawing from the Thames and Lea, and the total abandonment of the much-polluted Ravensbourne by the Kent Water Company. So long as the water was derived from the tidal reaches of the Thames and Lea, receiving the drainage of an immense population, the risk of infection from water-borne pathogenic organisms could scarcely be otherwise than imminent; for, although we now know efficient filtration to be a perfect safeguard, anything short of efficiency must be attended with risk in the presence of such extreme pollution.

Nevertheless, the line of demarcation between the past and the present water supply of the metropolis is, in my opinion, to be drawn, not when the intakes of the river companies were removed to positions beyond the possibility of pollution by the drainage of London; but, it must be drawn at the time when efficient filtration was finally secured and ever since maintained—that is to say, in the year 1884.

The removal of turbidity by sand filtration, however, refers only to suspended matter; but there are sometimes objectionable substances in solution, of which organic matter is the most important. River water and mountain water, even when efficiently filtered, contains more organic matter than spring or deep-well water; but this is reduced in quantity by storage and especially by filtration, although it can perhaps never be brought up to the standard of organic purity of spring and deep-well water.

The Present Water Supply.

At present London is supplied with water from four sources: the Thames, the Lea, the New River, and deep wells. Of these, the deep wells yield, as a rule, the purest water, requiring no filtration or treatment of any kind before delivery for domestic use. The river waters, on the other hand, require some kind of treatment before delivery—storage and subsidence in reservoirs, and filtration. The water from the Thames is abstracted at and beyond Hampton, that from the Lea is taken out at two points, viz. at Angel Road near Chingford, by the East London Water Company, and above Hertford by the New River Company, who convey it to Green Lanes by an open conduit twenty-five miles long, called the New River Cut, in which it is mixed with a considerable volume of spring and deep-well water.

Hitherto I have spoken of chemical purity, or comparative freedom from organic matter, only; but the spread of diseases, such as cholera and typhoid fever, through the agency of drinking-water, has no connection whatever with the chemical or organic purity of the water. These diseases are propagated by living organisms of extreme minuteness, to which the names bacilli, bacteria, microbes, and others have been given; and here comes the important question, how does filtration secure immunity from these water-borne diseases.

To Dr. Koch, of Berlin, we are indebted for the answer to this question. By his discovery of a means of isolating and counting the number of microbes and their spores in a given volume of water, we were, for the first time, put into possession of a method by which the condition of water as regards these living organisms, before and after filtration, could be determined with quantitative exactness. The enormous importance of this invention, which was first made known and practised in England in 1882 by the late Dr. Angus Smith, is evident when it is borne in mind that the living organisms, harmful or harmless, contained in water are of such extreme minuteness as, practically, to defy detection by ordinary microscopical examination. But, although the microscope cannot detect with certainty single bacteria or their spores, even the naked eye can easily discern towns or colonies consisting of thousands, or even millions, of such inhabitants.

Dr. Koch's method accomplishes at once two things: it isolates, in the first place, each individual microbe or germ; and, secondly, places it in conditions favourable for its multiplication, which takes place with such amazing rapidity that even in a few hours, or at most in two or three days, each organism will have created around itself a visible colony of innumerable members—a town, in fact, comparable to London itself for population. By operating upon a known volume of water, such as a cubic centimetre, for instance, the number of separate organisms or their spores in a given volume of the water under investigation can thus be determined.

In order to ascertain the effect of filtration upon the bacterial quality of the water, it is absolutely necessary that the sample should be taken immediately after it has passed through the sand filters; for, if it be obtained from the delivery mains in town—that is to say, after the water has passed through many miles of pipes—the rapid multiplication of these organisms, except in very cold weather, is such that a water which contains only a single living organism per c.c. as it issues from the filter, may contain 100 or 1000 in the same volume when, after several hours, it arrives at the consumer's premises.

Now, what is the effect of sand filtration, as carried out by the various water companies supplying London, upon the living matter contained in the raw river water? It is simply astounding—for water containing thousands of bacteria per c.c. (a single drop of Thames water sometimes contains three thousand separate living organisms) comes out from those filters with 50, 30, 10, or even less of these organisms per c.c., or the number of microbes in a single drop is reduced to 2, or even none.

Rather less than one-tenth of the total volume of water supplied to London is derived by the Kent Water Company from deep wells in the chalk. As it issues from the porous rock into the fissures and headings of these wells, this water is, in all probability, absolutely sterile; but by the time it has been

pumped up to the surface, it usually contains a small number of microbes. Thus during the year 1892 it contained, on the average, 6 per c.c.; in 1893, 13; in 1894, 15; and in 1895, 8.

Thus, although the deep-well water has, from a bacterial point of view, a decided advantage, the filtered river waters are not very far behind; and there is every reason to believe that, with the improvements which are now being carried out by the various river water companies, the Kent Company's water will, before long, be run very hard by the other supplies.

By the examination of the water as it issues from the filters, the utmost freedom from microbes, or maximum degree of sterility of each sample, is determined. This utmost freedom from bacterial life, after all sources of contamination have been passed, is obviously the most important moment in the history of the water; for, the smaller the number of microbes found in a given volume at that moment, the less is the probability of pathogenic organisms being present; and, although the non-pathogenic may afterwards multiply indefinitely, this is of no consequence in the primary absence of the pathogenic; but, it is only fair in describing the character of the present water supply of London to say that not a single pathogenic organism has ever been discovered even in the unfiltered water as it enters the intakes of the various companies, although these organisms have been diligently sought for. It is sometimes said that the non-pathogenic organisms found in water may be beneficial to man; but this idea is not borne out by their entire absence from the food which nature provides for young animals. Milk, if healthy, is absolutely sterile.

As it is at present impracticable to obtain water, uniformly at least, free from microbes, it is desirable to adopt some standard of bacterial purity, and 100 microbes per c.c. has been fixed upon, by Dr. Koch and myself, as the maximum number allowable in potable water. This standard is very rarely infringed by the London water companies, whilst I have every reason to hope that, in the near future, now that special attention is directed to bacterial filtration, it will not be approached within 50 per cent. This hope is based not only upon my own observations, but also upon the exhaustive and important investigations carried out at the Lawrence Experiment Station by the State Board of Health of Massachusetts, under the direction of Mr. George W. Fuller, the official biologist to the Board. More than six years have already been spent in the prosecution of these American experiments, and many thousands of samples of water have been submitted to bacterial cultivation.

These important experiments, and my own observations on the London waters continued for four years, lead to the following conclusions:—

(1) The rate of filtration between half a million and three million gallons per acre per day exercises, practically, no effect on the bacterial purity of the filtered water. It is worthy of note that the rates of filtration practised by the several water companies drawing their supplies from the Thames and Lea are as follows:—Chelsea Company, 1,830,000; West Middlesex, 1,359,072; Southwark Company, 1,568,160; Grand Junction Company, 1,986,336; Lambeth Company, 1,477,688; New River, 1,881,792; and East London, 1,393,920. Hence, not one of the London companies filters at the rate of two million gallons per acre per day; at which rate in the Massachusetts filters 99·9 per cent. of the microbes present in the raw water were removed.

(2) The effect of the size of the sand-grains used in the filters is very considerable. Thus, by the use of a finer sand than that employed by the Chelsea Company, the West Middlesex Company is able, with much less storage, to attain an equal degree of bacterial efficiency.

(3) The depth of sand, between the limits of 1 and 5 feet, exercises no practical effect upon bacterial purity, when the rate of filtration is kept within the limits just specified. Thus the New River Company, with 1·8 feet of sand on their filters, compares favourably with the Chelsea Company, the sand on whose filters is more than twice that depth. Placed in the order of thickness of sand on their filters, the Metropolitan companies range as follows:—Chelsea, Lambeth, West Middlesex, Southwark, East London, Grand Junction, and the New River. Placed in the order of efficient bacterial filtration, they range as follows:—Chelsea and West Middlesex (equal), New River, Lambeth, East London, Southwark, and Grand Junction.

(4) When there is such an accumulation of deposit on the surface of a sand-filter that, for practical purposes, sufficient water cannot be made to pass through it, the surface of the filter has to be scraped; that is to say, mud and about half an inch of the sand are removed from the surface. After this operation, there is often an increase in the number of bacteria in the filtered water, and it has been noticed that the increase is greater in shallow than in deep filters, and with high than with low rates of filtration; and there is no doubt that the effect of scraping is considerably magnified when the coarser descriptions of sand are employed, as is the case in the filters of the London water companies. I should therefore like to impress upon the engineers of these companies the desirability of using finer sands than are at present employed.

The lecturer here described a long series of experiments proving that the temperature of the water and the presence or absence of sunshine has little or no effect upon the number of microbes in river water, whilst the presence of flood water is almost invariably accompanied by an enormous increase in the number of microbes, showing that the microbial population of a river is directly dependent upon the volume of water flowing in its bed.

The Water Supply of the Future.

In view of the rapid increase of the population of London, fears have from time to time been entertained that the water supply from the Thames basin—that is to say, from the rivers Thames and Lea, supplemented by water from springs and deep wells within the basin itself—would soon be insufficient in quantity, whilst the quality of the water taken from the river has, up to comparatively recent date, been considered unsatisfactory. On these grounds various schemes have from time to time been brought forward for the supply of the metropolis from other river basins—from the Wye, the Severn, the river basins of North Wales, and of the lake districts of Cumberland and Westmoreland. It is worthy of note, however, that all the Royal Commissions have arrived unanimously at the conclusion that the quantity of water obtainable from the Thames basin is so ample as to render the necessity of going elsewhere a very remote contingency.

I shall now endeavour to put, very shortly, before you the facts which, in my opinion, prove that both as regards quantity and quality the Thames basin will, for a very long time to come, afford an abundant supply for the metropolis. There is, indeed, no river basin in Great Britain which affords such an abundant supply of excellent water as that available in the Thames basin. Besides that which flows directly into the rivers, this water is contained in the Chalk, Oolite, and Lower Greensand, which are the best water-bearing strata in the kingdom. From these strata it issues in copious springs of unsurpassed organic purity. For dietetic purposes there is no better water in the kingdom than the underground water of the Thames basin. For sentimental reasons, I should like to see it conveyed to the works of the various companies in special conduits; but we have seen that, on hygienic grounds, it may safely be allowed to flow down the bed of the Thames, if it be afterwards efficiently filtered.

So much for quality, now as to quantity. The basins of the Thames and Lea include an area of upwards of five thousand square miles. Of this, more than one-half, including the Oolitic, Cretaceous, and portions of the Tertiary formations, is covered by a porous soil upon a permeable water-bearing stratum. The remainder is occupied by the Oxford, Kimmeridge, Gault, and London clay; being thus covered by a clay soil upon a stiff and impervious subsoil. The annual rainfall of the district averages twenty-eight inches. The rivulets and streams of the Thames basin are formed and pursue their course on the clay land. There are no streams on the chalk. That which falls upon the porous stratum and does not evaporate sinks, mostly where it alights, and heaps itself up in the water-bearing stratum below, until the latter can hold no more. The water then escapes as springs at the lowest available points. Innumerable examples of these springs occur all round the edge of the Thames basin, and at various points within it. Thus from the Chalk they are ejected at the lip of the Gault, and in the Oolitic area by the Fuller's earth below it, or by the Oxford clay, geologically, above it.

According to the gaugings of the engineer of the Thames Conservancy Board, there passed over Teddington Weir, in 1892, 387,000 millions of gallons, equal to an average flow of 1060 millions daily. In the following year, 1893, there passed over this weir an aggregate of 324,227 millions of gallons, or a

daily average of 888 millions of gallons, the average for the two years being 974 millions of gallons; and this number does not include 120 millions of gallons daily abstracted by the five London water companies who draw their supplies from the Thames. Thus, in round numbers, we may say that, after the present wants of London have been supplied from this river, there is a daily average of nearly a thousand millions of gallons to spare. Surely it is not too violent an assumption to make that the enterprising engineers of this country can find the means of abstracting and storing, for the necessary time, one-fourth of this volume.

As regards the quality of this stored water, all my examinations of the effect of storage upon the chemical, and especially upon the bacterial quality, point to the conclusion that it would be excellent; indeed, the bacterial improvement of river water by storage, for even a few days, is beyond all expectation. Thus the storage of the Thames water by the Chelsea Company for only thirteen days reduces the number of microbes to one-fifth the original amount, and the storage of the river Lea water for fifteen days by the East London Company reduces the number, on the average, from 13,693 to 2752 per c.c., or to one-fifth. Indeed, quietness in a subsidence reservoir is, very curiously, far more fatal to bacterial life than the most violent agitation in contact with atmospheric air; for the microbes which are sent into the river above the Falls of Niagara by the city of Buffalo seem to take little or no harm from that tremendous leap and turmoil of waters; whilst they subsequently, very soon, almost entirely disappear in Lake Ontario. Thus it is not too much to expect that storage for, say, a couple of months, would reduce the number of microbes in Thames flood water down to nearly the minimum ever found in that river in dry weather; whilst, by avoiding the first rush of each flood, a good chemical quality would also be secured. There is therefore, I think, a fair prospect that the quantity of water derivable from the Thames at Hampton could be increased from its present amount (120 millions of gallons per diem) to 370 millions.

Again, in the river Lea, although here the necessary data for exact calculation are wanting, it may be assumed that the present supply of fifty-four millions of gallons could be increased by the storage of flood water to 100 millions of gallons per day. To these volumes must be added the amount of deep-well water which is obtainable from those parts of the Thames basin which lie below Teddington Lock; and in the Lea basin below Lea Bridge, and which was estimated by the last Royal Commission at rather more than 67½ millions of gallons. Thus we get the grand total of 537½ millions of gallons of excellent water obtainable within the Thames basin, the quality of which can be gradually improved, if it be considered necessary, by pumping from the water-bearing strata above Teddington and Lea Bridge respectively; instead of taking the total supply from the open rivers above these points. Such a volume of water would scarcely be required for the whole supply of the water area of London at the end of fifty years from the present time, even supposing the population to go on increasing at the same rate as it did in the decade 1881-91, which is an assumption scarcely likely to be verified.

In conclusion, I have shown that the Thames basin can furnish an ample supply for fifty or more years to come, whilst the quality of the spring and deep-well water and the efficiently-filtered river water would be unimpeachable. To secure these benefits for the future, storage must be gradually provided for 11,500 millions of gallons of flood water, judiciously selected, in the Thames Valley, and a proportionate volume in the basin of the Lea; whilst filtration must be carried to its utmost perfection by the use of finer sand than is at present employed, and by the maintenance of a uniform rate during the twenty-four hours.

The lecturer concluded as follows. There nothing heroic in laying pipes along the banks of the Thames, or even in making reservoirs in the Thames basin. They do not appeal to the imagination like that colossal work—the bringing of water to Birmingham from the mountains of Wales; and there is little in such a scheme to recommend it to the mind of the enterprising engineers of to-day. Nevertheless, by means of storage, by utilising springs, by sinking deep wells, and by such comparatively simple means, we have, in my opinion, every reason to congratulate ourselves that for half a century, at least, we have at our doors, so to speak, an ample supply of water which, for palatability, wholesomeness, and general excellence will not be surpassed by any supply in the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The Conference on Secondary Education, held in the Senate House on April 21 and 22, was largely attended by representatives of all the various educational authorities. The discussions were in some cases animated, and turned largely on the provisions of the new Education Bill; but the resolutions prepared, in support of the Report of the Royal Commission on Secondary Education, were in every instance passed by large majorities.

Dr. A. A. Kanthack, of St. John's College, has been appointed Deputy-Professor of Pathology for the present Term, in place of Prof. Roy, who is unable to lecture.

Dr. H. Frank Heath, Fellow of University College, London, has been elected Assistant Registrar in the University of London, in the place of Mr. Dickens, who has succeeded Mr. Milman as Registrar.

A special meeting of the Board of Governors of the Yorkshire College was held on Wednesday, April 23, in the Philosophical Hall, Leeds. The business before the meeting was to obtain the assent of the Governors to the borrowing by the Council of the College of £30,000 at 3 per cent. per annum on a mortgage of the real estate of the college situate in College Road (except such portion as is held in trust for the Clothworkers' Company), and of the new Medical School in Leeds. The motion was ultimately agreed to.

The annual report of the Whitworth Trustees has just been published, in which it is stated that a sum of £10,000, a portion of the surplus from the 1887 Exhibition, has been handed over to the Technical Instruction Committee of the Manchester Corporation for the purpose of erecting an additional wing to the School of Art in Cavendish Square of that city. We thought that satisfactory arrangements had been made for the accommodation of this art school in the new technical school which is being built at an estimated cost of £200,000.

The following are among recent appointments:—Dr. A. Fleischmann to be extraordinary professor of anatomy and zoology in Erlangen University, and director of the Zoologischen Universitäts, Anstalt; Dr. Pockels, *privat docent* in physics at Dresden Technical High School, to be professor; Dr. Oertel to be observer at the Königlichen Sternwarte in Munich, and Dr. Julius Bauschinger, of the same observatory, to be full professor of astronomy in the University of Berlin; Dr. H. W. Bakhuis Rosebom to be professor of chemistry at the University of Amsterdam, and Dr. A. Bistrzycki to be professor of analytical and technical chemistry in the University of Freiburg.

The Paris correspondent of the *Times* states that the General Council of the Paris Faculties has decided to send several delegates to the meeting of the Franco-Scottish Society to be held in Edinburgh in 1897. It has also decided to be represented at the jubilee of Lord Kelvin's connection with the University of Glasgow in June next. A similar decision was taken in reference to the Princeton College celebration *fêtes*. In this connection the Council passed a resolution in favour of closer relationship between French and foreign universities. It was declared that France held too much aloof from these international festivals, and did not sufficiently try to extend a knowledge of her scientific activity. But however this may be, it is certain that we have yet to cultivate the hospitality always freely and lavishly given when British men of science visit their French *confrères*.

The Report of the Council of the City and Guilds of London Institute upon the work of the Institute for the year 1895 has come to hand. Reference is made in it to the assistance which Prof. Huxley gave to the Committee appointed in 1877 to prepare an educational scheme. It was fitting that some permanent record of his connection with the Institute should be established, and the Council have been gratified to receive from the Fishmongers' Company an intimation that, in consideration of the eminent and important services rendered by Prof. Huxley to the cause of technical education, the Court of that Company have determined to found a Scholarship of £60 a year to be called the "Fishmongers' Company's Huxley Scholarship," to be awarded to a scholar of the Technical College, Finsbury, to enable him to proceed to the Central Technical College. In recalling the work of their late Chairman and of Prof. Huxley in the early years of the Institute, the Council are reminded of the great extension which this movement has undergone during

the past few years. In London alone the Technical Education Board of the London County Council, and the Central Governing Body of the City Parochial Charities are spending about £120,000 annually on technical education; and, probably, an equal amount is being spent in the same direction by the Livery Companies of London through the Institute or by individual action. Apart from the City and Guilds of London Institute, mention may be made of the Goldsmiths' Company's Institute, at New Cross; the support by the Drapers' Company of the People's Palace; and of the Skinners' and Saddlers' Companies of the Northampton Institute; the Carpenters' Company's Schools at Stratford and Great Titchfield Street; the Tanning School, recently established by the Leathersellers' Company in the Borough; and the technical schools and textile departments in Leeds, Bradford, Huddersfield, Halifax, and other towns in the north of England supported by the Clothworkers' Company, as a few of the institutions of a specially technical character to which individual Companies are devoting their funds. From a table given in the report to show the amount of the donations to the funds of the Institute since its foundation, we have extracted the following totals, running into four or more figures, which to some extent supplement the information given in a recent article on the grants of the City Companies to education and research. Goldsmiths' Company, £83,064; Clothworkers' Company, £71,500; Fishmongers' Company, £70,550; Drapers' Company, £50,500; Mercers' Company, £50,000; Skinners' Company, £25,835; Grocers' Company, £19,000; Corporation of London, £15,500; Salters' Company, £15,138; Merchant Taylors' Company, £14,657; Leathersellers' Company, £10,105; Carpenters' Company, £8155; Armourers' and Braziers' Company, £7700; Ironmongers' Company, £5973; Cordwainers' Company, £5878; Saddlers' Company, £5600; Dyers' Company, £4646; Coopers' Company, £2770; Vintners' Company, £2500; Pewterers' Company, £2019; Plaisterers' Company, £1537; Cutlers' Company, £1386. The present report furnishes the City Companies with food for congratulation upon the results of the generous provision they have made for technical education.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 24.—Captain W. de W. Abney, President, in the chair.—A paper by Mr. R. A. Lehfeld, on symbolism in thermodynamics, was, in the absence of the author, read by the Secretary. The author proposes a system of about twenty-four separate symbols for the different quantities in thermodynamics. Prof. Silvanus Thompson said he was not at all favourably impressed by the symbols proposed. In particular, it was becoming usual to restrict the use of Greek letters to the representation of specific quantities or angles, and the author's proposal seemed in this way a retrograde step. Prof. Perry said he did not care for the suggested symbols. Mr. Elder thought the author's system would be a very severe tax on the memory, for he did not make use of suffixes, as was ordinarily done, which in a great measure define the symbol to which they are attached.—Mr. Appleyard read a paper on the adjustment of the Kelvin Bridge. In a recent paper read before the Society, Mr. Reeves had described a modified form of Kelvin Bridge, in which a double adjustment was necessary. The author proposes to employ two wires stretched side by side, with a sliding contact in connection with the galvanometer on each. These contacts are rigidly connected together, so that the segments into which one wire is divided necessarily bear to one another the same ratio as do the segments of the other wire. Hence a single adjustment is sufficient to give balance. Mr. Reeves said that apparently the author had completely missed the object of his (the speaker's) paper. For the object there aimed at was to make use of such sets of resistance coils as are always to be found in any laboratory. In the author's arrangement it would be necessary to carefully calibrate the two wires, and also, since the resistances used must neceesarily be small, to determine the resistance of the contacts. Prof. Ayrton (communicated) said the author's suggestion was ingenious, but did not obviate the necessity for much of Mr. Reeves' "addition." Further, Mr. Reeves' proposal to employ ordinary resistance boxes was not made because such resistances are absolutely necessary, but because, since they are to be found in any electrical laboratory, their use saves the expense of such a wire resistance accurately calibrated as Mr. Appleyard employs. Mr. Appleyard, in his reply, said that his instrument was designed for use in a factory where the time saved in making a series of tests was of more importance than the cost of the instrument.—Mr. J. Frith read a paper on the effect of wave-form on the alternate current arc. The author finds that an arc has the power of modifying the wave-form in a circuit in which it is included. Thus in the case of a dynamo for which, on open circuit, the curve of E.M.F. was decidedly peaked, it was found that when this dynamo was employed to feed an arc that the curve became changed to a flat-topped form. It is interesting to remember that the candle-power of the arc is greater when the wave-form is flat-topped than when it is peaked. By altering the resistance in series with the arc it is possible to alter the character of the curve, for as the resistance in series with the arc increases the arc affects the wave-form less and less. In some recent experiments described by Dr. Fleming, a resistance of about 7 ohms was used in series with the arc, so that the wave-form of the generator, which is not an efficient form, was forced on the arc. In practice, however, where a resistance is not used in series with the arc, this is not the case, and the differences between the efficiency obtained for alternate current arcs in the laboratory and that claimed in practice may thus be accounted for.—Mr. Blakesley said it seemed as if the more nearly the alternate current resembles a direct current, *i.e.* the longer in each period the current remains constant, the greater is the efficiency of the arc.—Mr. Price asked what was the cause of the reaction of the arc on the wave-form.—Mr. Tremlett Carter asked whether previous observers' results were vitiated by this action of the arc on the wave-form?—Prof. Ayrton (communicated) considered the author's suggestion of great importance as bearing on the question of the efficiency of the alternate current arc.—Prof. S. P. Thompson said that the dynamo employed by the author was one in which there was a large quantity of iron in the armature, so that the self-induction was large. Was it not on account of this large coefficient of self-induction, which would tend to keep the current constant, that the arc was able to alter the wave-curve? If an arc is connected to the mains of a supply station in which a number of machines in parallel are feeding a number of lamps, would the arc still be able to affect the wave-form of the current?—Mr. Tremlett Carter asked if the author had tried the effect of replacing the arc by a resistance such that it would absorb the same volts as did the arc, and comparing the curves for the current and impressed P.D. with those obtained with the arc.—The author, in his reply, said that the effect of the self-induction of the machine was shown in the curves. Current curves had not been taken with the arc straight on the machine. The current and self-induction were the same for all the curves, the voltage of the machine being increased by increasing the field when a resistance was placed in series with the arc. When, as is commonly the case, special machines are used to supply arcs, and the load consists solely of arcs, the arcs could alter the character of the wave-form. If the arc is replaced by a resistance, the wave-form is of the same type as is obtained for the E.M.F. of the machine on open circuit.

PHILADELPHIA.

Academy of Natural Sciences, April 7.—Mr. J. Willcox described the process of obtaining quartz from the Oriskany sandstone of Pennsylvania to be used in the manufacture of glass.—Mr. G. Vaux, jun., called attention to recent additions to the William S. Vaux collection, which included superb crystals of calcite from the Joplin region, Missouri. They occur in caves opened for the working of lead and zinc. The several mines are characterised by distinct forms of the mineral. The sphalerite, which is largely present, is being deposited at the present time, the handles of shovels and picks left in the mines being found covered with crystals.—Mr. Theodore D. Rand described a fine collection of polished serpentines presented by him to the Academy from numerous localities in South-eastern Pennsylvania. They belong to two groups: one bordering the ancient gneiss, the other and the more recent occurring in the mica schists and gneisses. The former are altered igneous rocks, either crysolitic or pyroxenic, the chief material being Enstatite.—Dr. Bascom reported the microscopic examination of thin sections of serpentine from the Black Rocks of Lower Merion.—It was announced that Mr. G. Frederic Russell, accompanied by Dr. Juelal and a taxidermist, had started from Georgetown, British Guiana, March 11, on a collecting tour in the interior for the benefit of the Academy.

Paris.

Academy of Sciences, April 20.—M. A. Cornu in the chair.—On the subject of an unpublished letter of Gauss, by M. de Jonquières.—On a temporary case of parasitism of the *Glyciphagus domesticus* of Geer, by M. E. Perrier. An account of a case where this species of Acarus, usually free, became parasitic, with the result that two houses into which it was accidentally introduced became uninhabitable. Energetic measures of isolation and disinfection by sulphurous acid had to be adopted to stamp out the parasite.—The truffles (*Terfas*) of Mesrata, in Tripoli, by M. Ad. Chatin. — The extraction of the terpene alcohols contained in essential oils, by M. A. Haller. The essence is treated with a quantity of succinic or phthalic anhydride sufficient to convert the whole of the alcohol into the corresponding acid ether. Treatment of this with aqueous sodium carbonate gives the sodium salt of the acid ether, and this, digested with an excess of caustic soda, gives the alcohol free from hydrocarbons on appropriate purification. As an alternative method, the essence containing the alcohol is diluted with ether and treated with metallic sodium, then to the sodium derivative so formed the succinic or phthalic anhydride is added, and the salt worked up as before.—On the approximate value of the coefficients of terms of high order in the development of the principal part of the disturbance function, by M. A. Féraud. A study of the mutual influence of two planets upon each other, both of which are moving in elliptic orbits.—On the biuniform transformations of algebraic surfaces, by M. P. Painlevé.—On the diffraction of the Röntgen rays, by MM. L. Calmette and G. T. Lhuillier. By the use of two metallic screens pierced with narrow slits, photographs were obtained consistent with the assumption that the Röntgen rays exhibit the phenomenon of diffraction. The results obtained indicate that the wave-lengths are longer than those of light, but the photographs are hardly clear enough for exact measurement. The experiments are being continued.—Observations on a communication of MM. Benoist and Hurmuzescu, by M. A. Righi. A discussion of the conditions favourable to the discharge of an electrified body by the X-rays. The author maintains the accuracy of his earlier observations regarding the production of a positive charge upon isolated conductors by the Röntgen rays, and states that the potentials so produced are of the same order as contact electromotive forces. Hence a very delicate electrometer is required to exhibit these effects.—Photography in the interior of a Crookes' tube, by M. G. de Metz. The kathode rays in the interior of a Crookes' tube possess one of the properties of the Röntgen rays, inasmuch as they penetrate aluminium, cardboard and paper, but are stopped by platinum and copper.—Observations on the preceding, by M. Poincaré. The kathode rays, on striking the platinum or aluminium screen, may give rise to X-rays, which *then* go through the metallic plates. The kathode rays themselves may not necessarily possess this property.—On the compensation of the directing forces, and the sensibility of the galvanometer with moving coil, by M. H. Abraham. By attaching a small mass in front of the moving coil of a Deprez-d'Arsonval galvanometer so as to slightly displace its centre of gravity, and properly regulating the inclination of the instrument by means of its levelling screws, the effective sensibility is increased one hundred-fold, and is of the order of a Thomson galvanometer of equal resistance. —Rotatory dispersion of active non-polymerised liquid bodies, by MM. Ph. A. Guye and C. Jordan. An experimental study of normal and abnormal rotatory dispersion. The chief conclusions drawn are that active liquid bodies, not polymerised, present only normal rotatory dispersion, and that there is no simple relation between the refrangibility of the radiations and the rotatory dispersion.—On a new series of sulphophosphides, by M. Ferrand. These compounds, of which the copper, iron, silver, nickel, chromium, zinc, cadmium, mercury, lead, and aluminium salts are described, are thio-pyrophosphates, and possess the general formula $M'_4P_2S_7$.—The spontaneous adaptation of muscles to changes in their function, by M. Joachimsthal.—Influence of induced currents on the orientation of living bacteria, by M. L. Lortet. Living bacteria, in the form of mobile bacilli, are very sensible to the action of currents from a Ruhmkorff coil, and immediately set themselves in the direction of the current. This effect is only produced when the organisms are living, and is not observed after the introduction of an antiseptic, such as carbolic acid. Living organisms are unaffected by a constant current.—On the internal appendages of the male genital apparatus of the Orthoptera, by M. A. Fénard.—On the membrane of the *Ectocarpus fulvescens*, by M. C. Sauvageau.—On the abortion of the principal root in one species of the genus *Impatiens* (L.), by M. C. Brunotte.—The biochemical preparation of sorbose, by M. G. Bertrand. A specific organism, which can be obtained by exposing a mixture of wine and vinegar to the air for some time, is the cause of the conversion of sorbite into sorbose in the fermentation of the juice of various species of *Sorbus*. The direct production of sorbose in the fermentation of the latter is dependent upon the introduction of the organism by small reddish flies (the vinegar fly, *Drosophila funebris*).—On winter observations in the caves of the Causses (Padirac, &c.), by M. E. A. Martel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—A Scientific Demonstration of the Future Life: T. J. Hudson (Putnam).—Studies in Ancient History: J. F. M'Lennan, 2nd series (Macmillan).—A Dictionary of Chemical Solubilities. Inorganic: Dr. A. M. Comey (Macmillan).—The Theory of Sound: Lord Rayleigh, Vol. 2, new edition (Macmillan).—Analytical Psychology: J. F. Stout, 2 Vols. (Sonnenschein).—Forschungsberichte aus der Biologischen Station zu Plön: Dr. O. Zacharias, Theil 4 (Berlin, Friedländer).—Know your own Ship: T. Walton (Griffin).—Annals of the Royal Botanic Garden, Calcutta, Vol. v. Part 1 (Calcutta).—The American Lobster: Dr. F. H. Herrick (Washington).—Artistic and Scientific Taxidermy and Modelling: M. Browne (Black.—Royal University of Ireland. Examination Papers, 1895: a Supplement to the University Calendar for the Year 1896 (Dublin).

Pamphlets.—The Physiology of the Carbohydrates: a Rejoinder to Dr. Paton's further Criticism: Dr. F. W. Pavy (Churchill).—City and Guilds of London Institute Report to the Governors, March 1896 (Gresham College). —Neber einige Eigenschaften der Röntgen, schen X-Strahlen: Drs. Winkelmann and Straubel (Jena, Fischer).

Serials.—English Illustrated Magazine, May (198 Strand).—Quarterly Review, April (Murray).—Good Words, May (Isbister).—Sunday Magazine, May (Isbister).—American Journal of Psychology, Vol. 7, No. 3 (Worcester, Mass.).—Encyklopædie der Naturwissenschaften, Dritte Abthg., 30 to 33 Liefg. (Breslau, Trewendt).—Journal of the Sanitary Institute, April (Stanford).—Longman's Magazine, May (Longmans).—Chambers's Journal, May (Chambers).—Terrestrial Magnetism, No. 2 (Chicago).—Journal of the Asiatic Society of Bengal, Vol. lxiv. Part 2, No. 3 (Calcutta).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1895, Part 3 (Philadelphia).—Bulletin of the American Museum of Natural History, Vol vii. (New York).—Field Columbian Museum. Archaeological Studies among the Ancient Cities of Mexico, Part 1: W. H. Holmes (Chicago).—Natural Science, May (Rait).—Schriften der Naturforschenden Gesellschaft in Danzig. Neue Folge, Neunten Bandes, Erstes Heft (Danzig).

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